FISHERIES REPORT
02-04

TROUT FISHERIES REPORT
REGION IV
2001

Prepared by:

James W. Habera
Rick D. Bivens
Bart D. Carter
Carl E. Williams

Tennessee Wildlife Resources Agency

*Visit our website at ***www.twra4streams.homestead.com/32700.html*** where you can download this report and learn more about TWRA Region IV stream fisheries projects and activities. You can also reach the Region IV streams site through the main TWRA website at ***www.tnwildlife.org***.

Cover: Large rainbow (top) and brown trout collected during annual electrofishing surveys on the Clinch and South Holston (daytime photo) tailwaters in 2001.

TROUT FISHERIES REPORT
REGION IV
2001

Prepared by:

James W. Habera
Rick D. Bivens
Bart D. Carter
and
Carl E. Williams

TENNESSEE WILDLIFE RESOURCES AGENCY

May 2002

This report contains progress and accomplishments for the following TWRA Projects: "Stream Survey".

Development of this report was financed in part by funds from Federal Aid in Fish and Wildlife Restoration (Public Law 91-503) as documented in Federal Aid Project FW-6 (4321, 4350, and 4351)

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

1. INTRODUCTION

The Tennessee Wildlife Resources Agency (TWRA) manages trout fisheries in streams, tailwaters, and reservoirs in Region IV. Some of these fisheries, such as the South Holston and Watauga tailwaters, have gained regional and even national prominence because of their quality. Aesthetically pleasing surroundings are essential components of others, such as our mountain wild trout streams. Together, Tennessee's trout fisheries provide a popular and important set of angling opportunities. Agency management emphasizes habitat preservation and the maintenance of wild stocks where they occur. However, artificially propagated trout, produced at six state and federal hatcheries, are also important for managing substantial portions of Tennessee's coldwater resource.

The Blue Ridge physiographic province of eastern Tennessee contains about 1,000 km (621 mi) of coldwater streams inhabited by wild (self-sustaining) populations of rainbow trout *Oncorhynchus mykiss*, brook trout *Salvelinus fontinalis*, and brown trout *Salmo trutta*. Tennessee's wild trout primarily occur within the nine counties that border North Carolina, as well as parts of Sullivan and Washington counties (Figure 1-1). Small populations may exist elsewhere (e.g., in some Cumberland Plateau and spring-fed streams), but would represent a small fraction of the resource. The Tennessee portion of Great Smoky Mountains National Park (GSMNP) in Cocke, Sevier, and Blount counties contains another 395 km (245 mi) of wild trout streams. Most of Tennessee's wild trout resource outside GSMNP is located within the U.S. Forest Service's (USFS) 253,000-hectare (625,000-acre) Cherokee National Forest (CNF). However, a substantial portion (~30%) occurs on privately owned lands and includes some of the State's best wild trout streams.

Rainbow trout, native to Pacific-drainage streams of the western U.S., and brown trout, native to Europe, were widely introduced into coldwater habitats during the past century and have become naturalized in many Tennessee streams. Brook trout are Tennessee's only native salmonid and once occurred at elevations as low as 490 m (1,600 ft) in some streams (King 1937). Brook trout now inhabit about 237 km (148 mi) in 106 streams, or about 24% of the stream length supporting wild trout outside GSMNP. Brook trout occur allopatrically in about 68% of the stream length the currently occupy.

Wild trout populations reflect the quality and stability of the aquatic systems they inhabit, which is linked to the quality and stability of associated terrestrial systems. TWRA recognizes the ecological importance of Tennessee's wild trout resources, along with their value to anglers and the special management opportunities they offer. The Agency's Streams and Rivers Strategic Plan (TWRA 2000) acknowledges the continued need for trout population, habitat, and angler use data. Such information is essential to ensure that wild trout resources are protected and that appropriate management strategies can be developed and employed while maintaining angler satisfaction. TWRA has been intensively involved in obtaining and utilizing this information since 1990.

Many smaller Tennessee streams with unregulated flows can support trout fisheries, but are limited by marginal habitat or levels of natural production insufficient to meet existing fishing pressure. TWRA maintains trout fisheries in about 467 km of such streams in eastern Tennessee by annually stocking hatchery-produced trout (fingerlings and adults).

Cold, hypolimnetic releases from four Tennessee Valley Authority (TVA) dams in Region IV (Norris, Ft. Patrick Henry, South Holston, and Wilbur) also support year-round trout fisheries in the rivers downstream (Figure 1-2). Temperatures in these hydropower tailwaters are regulated by the release of winter-cooled water from the upstream reservoirs. These larger waters generally have habitats and food bases that support large carrying capacities and allow trout to grow larger than they normally do in other streams. Tailwaters are stocked with fingerlings in the early spring and adult fish (catchables) throughout the summer. Adults supplement the catch during peak angling season and by fall, fingerlings have begun to enter these fisheries. Recruitment of natural reproduction (mostly by brown trout) contributes substantially to the fishery in the South Holston tailwater and, to a lesser extent, in the Wilbur (Watauga River) tailwater. Another tailwater trout fishery is developing in the Holston River below Cherokee Reservoir (Figure 1-2) and it now appears that it will also provide year-round angling opportunities.

Reservoirs that stratify during summer months and have water that is suitable for trout below depths normally occupied by warmwater species are termed "two-story" fisheries. These reservoirs must have a zone with water below 21°C and a minimum dissolved oxygen concentration of 3.0 mg/L (Wilkins et al. 1967). Seven two-story reservoirs in Region IV (Calderwood, Chilhowee, Tellico, Ft. Patrick Henry, South Holston, Wilbur, and Watauga) have such zones and create an additional trout resource. These reservoirs are stocked with adult-size trout during the late fall and winter when reservoir temperatures are uniformly cold, and piscivorous warmwater predators are less active.

The goal of TWRA's new Streams and Rivers Strategic Plan (TWRA 2000) is to ”protect, restore, and enhance stream and river fisheries while providing a variety of quality angling opportunities.” Tennessee's trout fisheries help meet that goal by supporting over a million trips a year by more than 100,000 anglers (resident and nonresident). TWRA would like to increase the use of streams and rivers by 2006 to 2.5 million fishing trips/year by 250,000 Tennesseeans while maintaining a 70% level of satisfaction for success and overall recreational experience (TWRA 2000). To help meet this objective, new trout fishing opportunities, as well as proper management of existing opportunities, will be necessary. Acquisition of basic trout population data (e.g., abundances, size structures, age and growth characteristics, mortality rates, etc.) through standardized stream survey techniques will continue to be an important means for meeting these needs.

Wild Trout Distribution

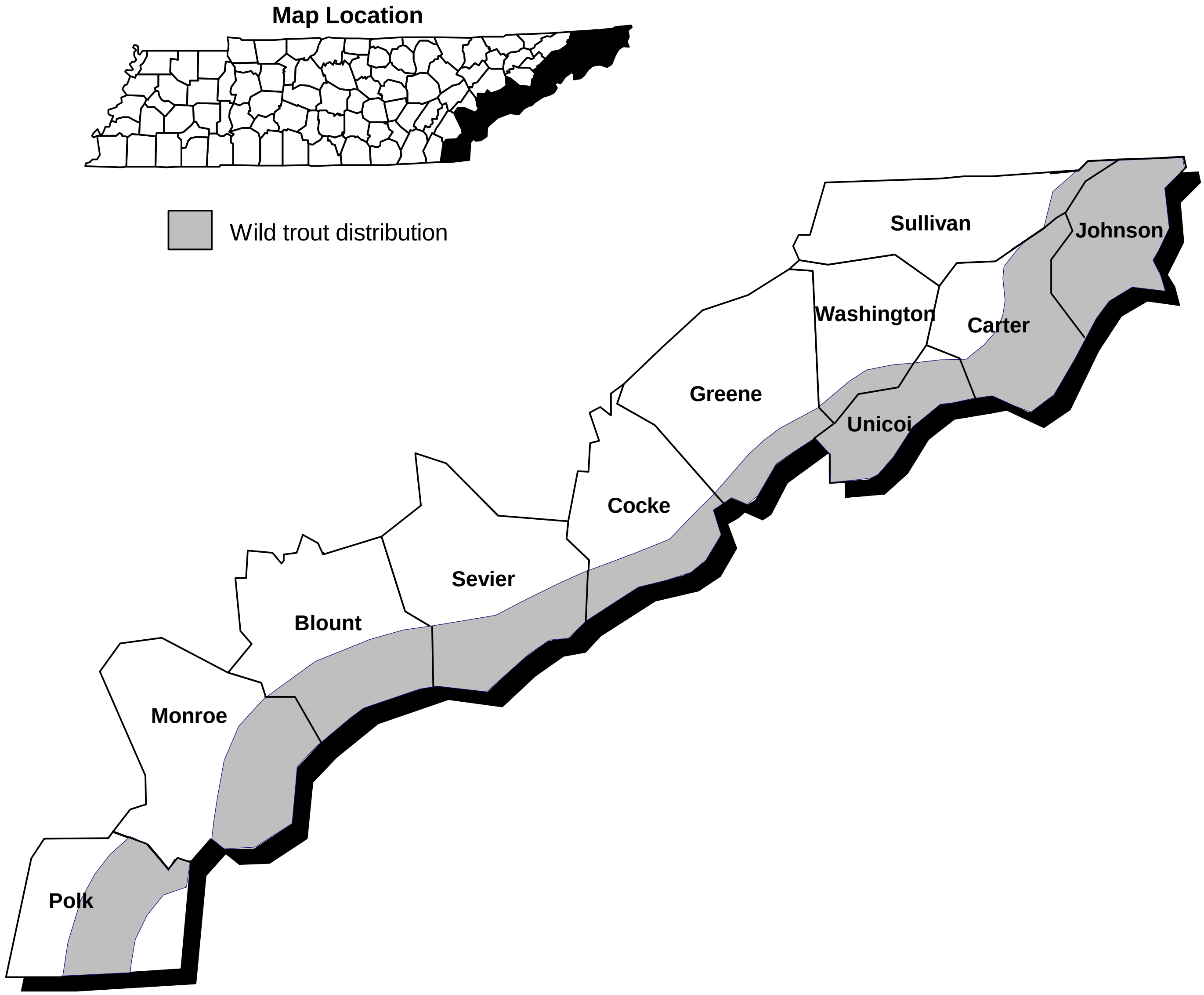


Figure 1-1. Primary wild trout distribution in Tennessee.

Trout Tailwaters and Reservoirs

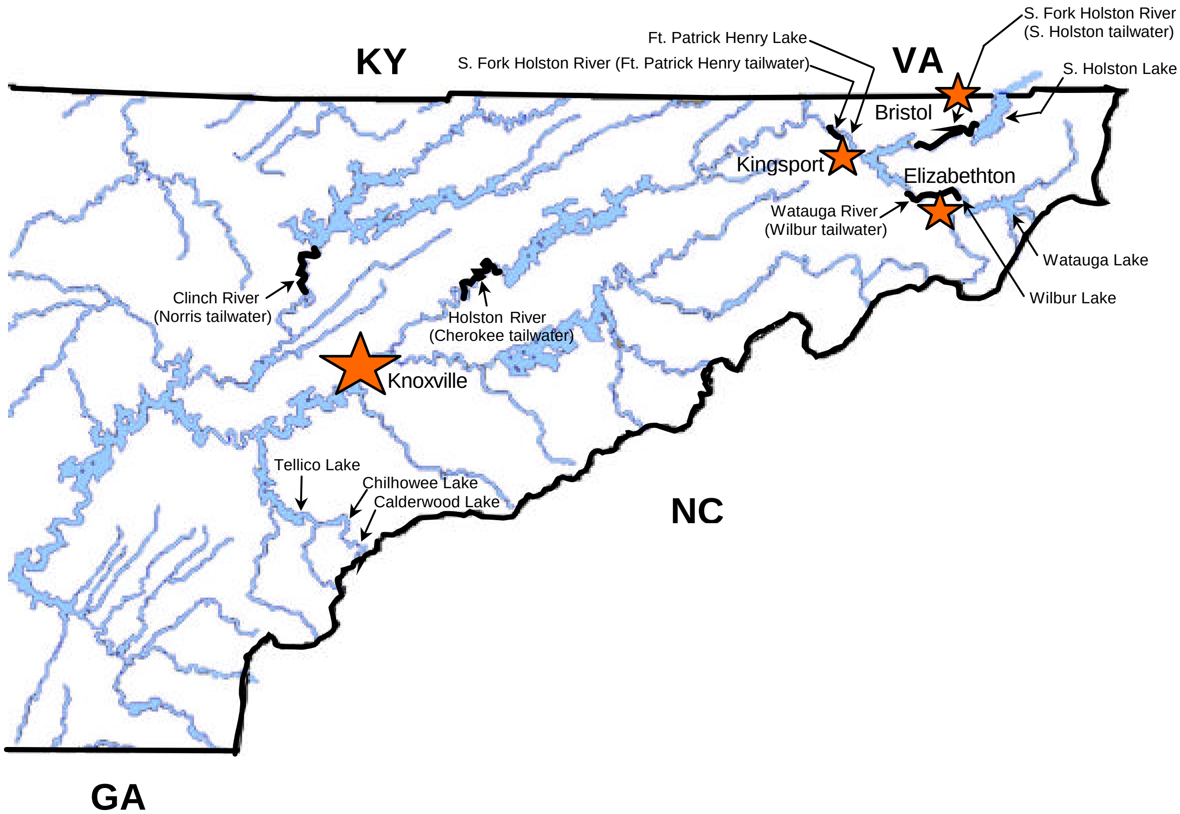


Figure 1-2. The five tailwater and seven reservoir trout fisheries in Region IV.

2. WILD TROUT STREAM ACCOUNTS

Fourteen wild trout streams in the Tellico/Little Tennessee, French Broad, Nolichucky, Watauga, and South Fork Holston river watersheds were quantitatively sampled during the 2001 field season (June - October). The 22 sample stations on these streams were located in Monroe, Cocke, Greene, Washington, Unicoi, Carter, and Johnson counties. Seven stations were located on privately owned land, three were located on State-owned land (Hampton Cove State Natural Area), and the others were located in the CNF. A qualitative survey of upper Little Jacobs Creek (Sullivan County) in August documented reproduction by brook trout transplanted there in 2000 (Habera et al. 2001). The Clinch River tailwater below Norris Dam (12 stations), Watauga River tailwater below Wilbur dam (12 stations), and the South Fork Holston River tailwater below South Holston Dam (12 stations) were also sampled.

Sampling efforts in some of the larger wild trout streams during 2001 involved cooperation and field assistance by National Park Service (NPS), USFS, Tennessee Valley Authority (TVA), and Trout Unlimited personnel. In return, Region IV personnel assisted the NPS with efforts in GSMNP to remove rainbow trout and restore brook trout in Sams Creek, as well as with monitoring station samples on Little River. Such cooperation permits larger projects to be undertaken and serves as an important means for communication among the agencies managing wild trout populations and habitat in Tennessee. Maintenance of interagency cooperation and coordination of sampling activities and reporting is one of the strategies for addressing the information needs outlined in TWRA's current Streams and Rivers Strategic Plan (TWRA 2000).

The following sections provide individual accounts for all streams and tailwaters sampled quantitatively during 2001. A list of all streams sampled quantitatively during 1991-2001 is provided in Appendix A.

2.1 SAMPLING METHODS

All sampling in wild trout streams was conducted with gasoline-powered backpack electrofishing units (125-600 VAC, depending upon water conductivity) and followed the standard protocols for three-pass depletion sampling (TWRA 1998). This quantitative sampling methodology is recommended by the American Fisheries Society, Southern Division Trout Committee's Standardized Sampling Guidelines for Wadeable Trout Streams and is widely used by the other state and federal agencies working with wild trout in the region. Stocked rainbow trout, distinguishable by dull coloration, eroded fins, atypical body proportions, and large size (usually >229 mm), were noted on data sheets but were not included in any analyses. A list of the common and scientific names of all fish collected during 2001 sampling efforts in wild trout streams is provided in Table 2-1.

Table 2-1. List of common and scientific names of fishes collected during 2001 trout stream surveys[1].

Common Name	Scientific Name
Minnows	Cyprinidae
Central stoneroller	*Campostoma anomalum*
Rosyside dace	*Clinostomus funduloides*[2]
Warpaint shiner	*Luxilus coccogenis*
River chub	*Nocomis micropogon*
Tennessee shiner	*Notropis leuciodus*
Saffron shiner	*Notropis rubricroceus*
Mountain redbelly dace	*Phoxinus oreas*[3]
Tennessee dace	*Phoxinus tennesseensis*
Blacknose dace	*Rhinichthys atratulus*
Longnose dace	*Rhinichthys cataractae*
Creek chub	*Semotilus atromaculatus*
Suckers	Catostomidae
White sucker	*Catostomus commersoni*
Northern hog sucker	*Hypentelium nigricans*
Trouts	Salmonidae
Rainbow trout	*Oncorhynchus mykiss*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*
Sculpins	Cottidae
Mottled sculpin	*Cottus bairdi*
Sunfishes	Centrarchidae
Rock bass	*Ambloplites rupestris*
Bluegill	*Lepomis macrochirus*
Perches	Percidae
Greenfin darter	*Etheostoma chlorobranchium*
Fantail darter	*Etheostoma flabellare*
Snubnose darter	*Etheostoma simoterum*
Swannanoa darter	*Etheostoma swannanoa*

[1]Nomenclature follows Robins et al. (1991) and Etnier and Starnes (1993).
[2]Undescribed subspecies (Etnier and Starnes 1993).
[3]Specimens from Laurel Creek (Johnson Co.); first collection of this species in Tennessee.

Removal-depletion data were analyzed with *MicroFish 3.0* (Van Deventer and Platts 1989). Trout ?90 mm in length were analyzed separately from those >90 mm. Trout in the smaller size-group (<90 mm) tend to have lower catchabilities (Strange and Habera 1992-1998a), making separate analysis necessary to avoid bias. These two groups also roughly correspond to young-of-the-year (YOY or age-0) and adults. Scale samples were not obtained in 2001 except in a few cases where otoliths were collected from marked (known-age) fish.

Qualitative benthic sampling was discontinued at most long-term monitoring stations on wild trout streams in 2001. The 10 years of data collected to date indicated that species composition and abundance had been adequately characterized on these streams and no particular trends were evident. Benthic sampling was conducted on Tellico River, Doe Creek, and upper Trail Fork Big Creek in 2001. These samples were obtained with aquatic insect nets, by rock turning, and by selective pickings from as many different habitats as possible within the sample area. Benthic samples were timed efforts resulting in a total of 3 h expended at each site (usually 1 h of effort by three collectors). Organisms were preserved in 50% isopropanol, then sorted and enumerated in the laboratory. Attempts were made to identify specimens to species when possible. Many were identified to the genus level, and most were identified at least to family. Dr. David A. Etnier (University of Tennessee) examined problematic specimens and either made the determination or confirmed our identifications. Comparisons with identified specimens in our aquatic invertebrate collection were also useful in making determinations. For the most part, nomenclature of aquatic insects used in this report follows Brigham et al. (1982). Names of lotic dragonflies (Odonata) follow Louton (1982) and names of stoneflies (Plecoptera) are after Stewart and Stark (1988), from which many of the determinations were also made. Names of caddisflies are from Etnier et al. (1998) and Wiggins (1996). Benthic results are reported in table form with each appropriate stream account.

Estimates of taxa richness and relative abundance were the primary objectives of the benthic sampling. Taxa richness reflects the relative health of the aquatic community and biological impairment is reflected in the absence of pollution-sensitive taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT). Bioclassification of streams in this report, based on the overall taxa tolerance values and the EPT taxa richness, is from criteria developed for the Blue Ridge mountain ecoregion by the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR 1995; Lenat 1993). Classifications under these criteria are as follows:

Score	Biotic Index Values	EPT Values
5.0 (Excellent)	<4.00	>43
4.6	4.00-4.04	42-43
4.4	4.05-4.09	40-41
4.0 (Good)	4.10-4.83	34-39
3.6	4.84-4.88	32-33

Score	Biotic Index Values	EPT Values
3.4	4.89-4.93	30-31
3.0 (Fair-Good)	4.94-5.69	24-29
2.6	5.70-5.74	22-23
2.4	5.75-5.79	20-21
2.0 (Fair)	5.80-6.95	14-19
1.6	6.96-7.00	12-13
1.4	7.01-7.05	10-11
1.0 (Poor)	>7.05	0-9

2.2 LONG-TERM MONITORING STREAMS

Long-term monitoring stations established on Tellico River, North River, Rocky Fork, Left Prong Hampton Creek, Right Prong of Middle Branch, Doe Creek, and Beaverdam Creek were sampled again during 2001. Bald River and Laurel Fork (each sampled the previous 10 years) were rotated off the monitoring stream set in 2001 and Laurel Creek in Johnson County was added. Some of the other original monitoring streams will be periodically replaced on the sampling schedule in coming years (e.g., by Paint Creek, Doe River, and Stony Creek) to broaden our knowledge of Tennessee's wild trout fisheries. Some of the more important information obtained from the long-term monitoring efforts includes documentation of annual variability in wild trout abundance, estimates of annual mortality (total), and evaluation of the effects of floods and other environmental events.

2.2.1 Tellico River

Study Area

The headwaters of Tellico River are located in the Nantahala National Forest in North Carolina. In Tennessee, Tellico River is a Little Tennessee River tributary with a forested watershed, most of which lies within the CNF (Tellico Wildlife Management Area) in Monroe County. Excluding tailwaters, Tellico River is Tennessee's largest and probably best-known put-and-take trout fishery. About 75,000 catchable-size rainbow trout, supplied by TWRA's Tellico Hatchery, are stocked annually in the 20.3 km from Turkey Creek to the state line (Bivens et al. 1998). In addition to the stocked fish, Tellico River also supports excellent populations of wild rainbow and brown trout. Brook trout are present in the upper Tellico River in North Carolina, as well as in Rough Ridge Creek and Sycamore Creek, which are two direct tributaries in Tennessee (Strange and Habera 1997).

Shields (1951) considered Tellico River's trout fishery to be marginal because of elevated temperatures and heavy siltation from logging operations in North Carolina. He also mentioned that brown trout stocking, which had begun in 1938, should be discontinued.

Conditions have obviously improved, but upper Tellico River is still subject to turbidity problems caused by runoff from about 65 km of off-highway vehicle trails in the Nantahala National Forest in North Carolina. Turbidity conditions during storm events, in terms of total suspended sediment (TSS), ranked as poor at 11 stations recently studied in the upper Tellico River watershed (G. Williams, TVA, unpublished data). However, implementation of Best Management Practices (BMPs) by the USFS is apparently helping to reduce storm event TSS at the North Carolina/Tennessee state line (G. Williams, TVA, unpublished data).

Tellico River has been subject to general trout regulations (seven-fish creel limit and no size limit) for many years. Beginning in 1994, the special-permit requirement and closed days (Thursdays and Fridays) were suspended during October through February (when there is no stocking) in recognition of the wild trout fishery. A delayed-harvest fishery was established on Tellico River in October 2001, extending from the mouth of Turkey Creek downstream to the Oosterneck Recreation Area. This will be a hatchery-supported fishery with a catch-and-release season (artificial lures only) effective October 1 through March 14 each year.

Bates (1997) conducted a creel survey on upper Tellico River in 1995 and 1996 and determined that the stream received an average angling effort of 3,508 hrs/ha. Anglers caught an estimated 20,299 stocked trout (1.24 fish/hr) and 15,355 wild trout (0.53 fish/hr) per year (Bates 1997). The estimated wild trout catch exceeded the estimated abundance of adults by a factor of 2.5, indicating numerous recaptures (Strange and Habera 1997). The wild trout release rate was 95% (Bates 1997), yielding a relatively low estimate of annual fishing mortality or exploitation (12.3%; Strange and Habera 1997).

Two stations on Tellico River were quantitatively sampled in 1993 (Bivens et al. 1994; Strange and Habera 1994) and again in 1995 (Bivens et al. 1996; Strange and Habera 1996). These stations were added to the long-term monitoring program in 1996. A third station just downstream of Tellico Hatchery's discharge was also established in 1996 at the request of TWRA's Environmental Services Division and the Tennessee Department of Environment and Conservation (TDEC). All three stations (Figure 2-1) have been sampled since 1996. Site location and sampling effort details, along with habitat and water quality information are summarized in Table 2-2.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Tellico River stations in 2001 are given in Table 2-3. Total trout density estimates increased somewhat at stations 1 and 2 relative to 2000 (Figure 2-2), while total standing crops were relatively unchanged. The relative standing crop of brown trout at Station 1 has gradually increased since 1997 and surpassed that of rainbow trout in 2001. This also occurred at Station 2 in 1999 and 2000, rainbow trout standing crop was greater in 2001. Trout abundance (total density and standing crop) decreased at Station 3 in 2001 after the notable increase in 2000 (Figure 2-2). Standing crop at Station 3 remains somewhat below the pre-flood (1993) estimate (Figure 2-2). Recent trout abundance declines are likely attributable to the dry conditions prevalent during the past three years. Relative abundance shifts favoring brown trout may also be a result of temperature and habitat changes related to the lower flows.

Non-salmonid density estimates decreased again at all stations in 2001, maintaining the trend that began in 1998 (Figure 2-3). Total standing crop changed little at stations 1 and 3, but decreased at Station 2 (Figure 2-3). Cyprinid abundance, however, decreased at all three stations in 2001. The fantail darter population (Station 1) had expanded to over twice its 1993 abundance during 1995-1999, but has declined since 1999. No explanation is evident, but the fantail darter population in lower North River has behaved similarly (Section 2.2.3). Despite lower diversity, Station 2 has a mean non-salmonid standing crop that has typically exceeded Station 1 (Figure 2-3). This might reflect enrichment (i.e., increased stream fertility) related to the proximity of the hatchery discharge.

Strong cohorts of age-0 fish were again present for both species at all three stations in 2001 (Figure 2-4). Despite the size of Tellico River, only a few large brown trout have been collected during previous monitoring efforts. One 370-mm (14”) individual was collected at Station 1 in 2001 (Figure 2-4).

The proportion of adult rainbow trout in the 178-228 mm (7-8 in) and ?229 mm (?9 in) size groups has typically ranged from 30-60% and 5-10%, respectively (Figure 2-5). This is comparable to other wild trout populations even though no minimum size limit or gear restrictions apply and fishing pressure is extreme. However, rainbow trout in both size groups have steadily declined since 1998 (Figure 2-5). During each survey year, over 80% of all adult brown trout collected were 178 mm or larger (Figure 2-5). The relative proportion of adult brown trout ?229 mm has substantially declined since 1999.

Mean backcalculated lengths at age and mean capture lengths for rainbow and brown trout during 1993-1997, based on scales (Strange and Habera 1998a), are given below. Total annual mortality (catch curve) was estimated to be 81% for rainbow trout and 53% for brown trout (Strange and Habera 1998a).

	Mean Length at Age (mm)				
	0	1	2	3	4
Rainbow (backcalculated)		119	181	212	
Rainbow (at capture)	101	167	209	237	
Brown (backcalculated)		138	229	305	315
Brown (at capture)	123	209	270	376	355

Age-0 rainbow trout were adipose clipped at each station in 1997 for future age validation purposes. Forty-seven were recaptured in 1998 at age 1 (average length, 170 mm), three were recaptured in 1999 at age 2 (average length, 208 mm), and none were recaptured in 2000 or 2001. Mean lengths at capture for the known-age fish were comparable to those listed above. Additionally, the lack of marked fish in the 2000 and 2001 samples confirms the lack of older fish identified using scales and the relatively high estimated annual mortality rate. No micro-wire tagged brown trout released in 1996 as fingerlings were recaptured in 2001. Analyses of otoliths from brown trout collected in Tellico River in 1996 documented the presence of fish up to age 6. Rainbow trout otoliths will also be collected and analyzed to validate scale-derived age and growth characteristics.

Benthic macroinvertebrates collected at sites 1 (16 October) and 3 (18 October) comprised 45 families representing 50 identified genera (Tables 2-4 and 2-5). The most abundant organisms were caddisflies, stoneflies, and mayflies, which together represented 80-92% of each sample. Total taxa richness was 55 at Site 1 and decreased to 41 at Site 3, although EPT taxa richness was similar (32 at Site 1; 29 at Site 2). Based on the EPT taxa richness values and the overall biotic index at each site, the relative health of the benthic community was classified as good at both sites. Benthic taxa richness has been relatively stable at both sites since 1993, while the abundance of benthic organisms has been more variable (200-600; Figure 2-6).

Benthic sampling was also conducted again (21 November) at sites above and below the Tellico Hatchery discharge to evaluate any associated impacts on the benthic community and compliance with the National Pollution Discharge Elimination System permit. Benthic macroinvertebrates above the discharge increased to 35 families representing 40 identified genera in 2001 (Table 2-6). Taxa richness and EPT taxa richness also increased considerably at this site compared with 2000 (53% and 44%, respectively) and previous years (Figure 2-7). The increases may be related to ideal sampling conditions in 2001 (including low flows), as they also occurred at the site below the discharge (although to a lesser extent). The sample below the hatchery discharge comprised 38 families and 44 identified genera (Table 2-7) in 2001. Total taxa richness increased 13% (Figure 2-7), but EPT taxa richness decreased (Figure 2-7). As with previous samples, most of the families and genera identified were present in both samples. The most abundant organisms above the discharge were caddisflies, stoneflies, and mayflies (83%). The same three taxa were also most abundant below the discharge (78%). Total taxa richness (54) and organism abundance (770) remained highest below the discharge in 2001(Figure 2-7; Table 2-7), but EPT taxa richness (36) was higher above the discharge for the first time since sampling began (Figure 2-7; Table 2-6). Based on the overall biotic index at each site (4.0 below discharge, 4.5 above), relative benthic community health was classified as “good”. Bioclassification has been the same at both sites since sampling began (“good” since 1996), suggesting there is no negative impact from the discharge on benthic community. In fact, there may actually be a positive effect in the form of slight but beneficial organic enrichment of the naturally oligotrophic system.

Management Recommendations

Tellico River’s intensive management as a put-and-take trout fishery is quite popular with anglers and no changes are recommended. The addition of the delayed harvest area will provide anglers with a new fishing opportunity in this stream during the fall and winter. The resident population of wild trout appears to be capable of coexisting with the hatchery-supported fishery and, in terms of abundance, is rivaled in this part of Tennessee only by Bald River. Despite its high-pressure put-and-take fishery (numerous wild trout are also caught) and lack of special regulations, Tellico River still supports relatively abundant wild trout populations, suggests that restrictive size and creel limits may currently have limited value for managing other area streams. Annual monitoring of the three Tellico River stations should continue next year in order to increase our understanding of wild trout population dynamics in this stream.

Tellico River Monitoring Stations

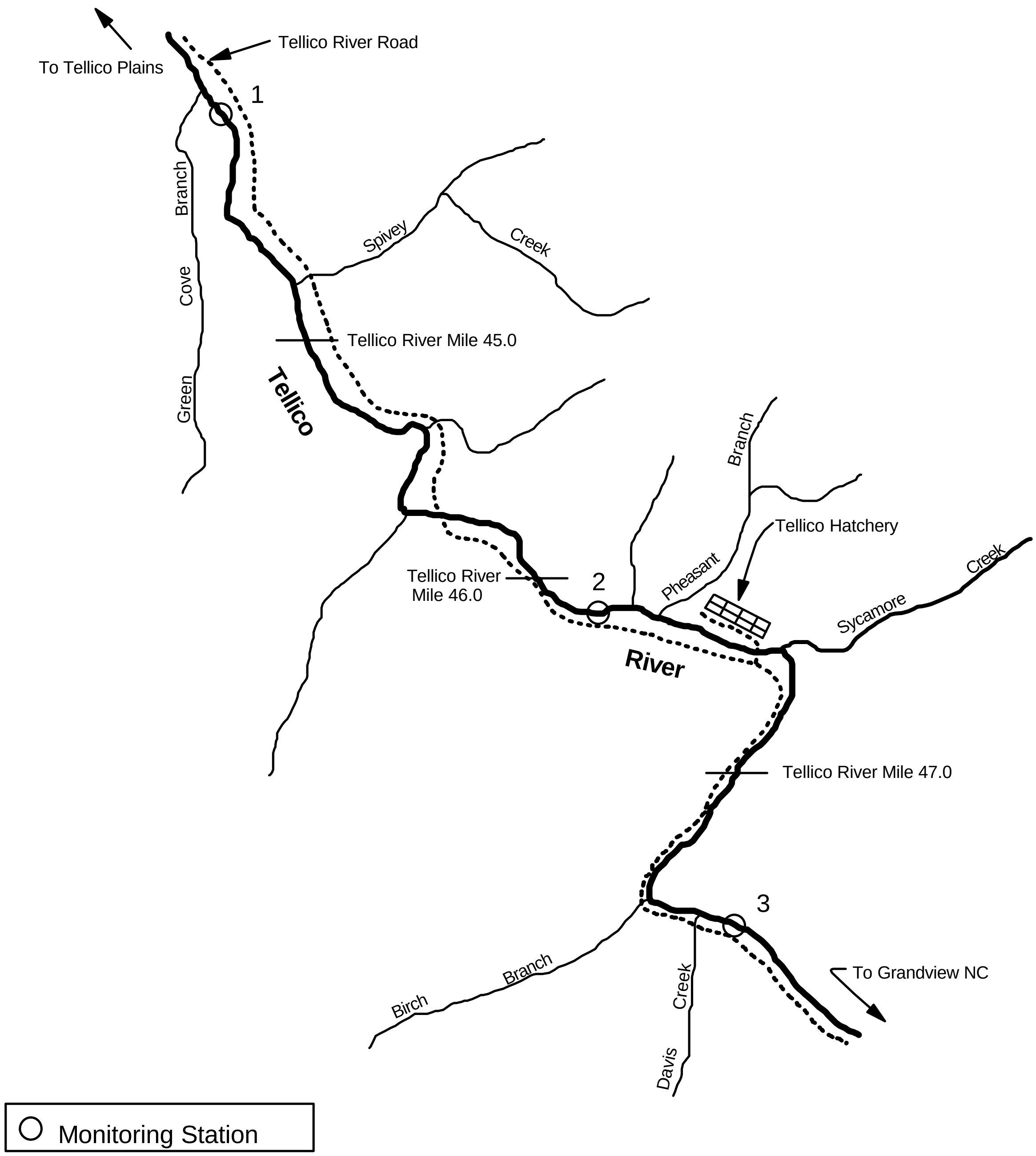


Figure 2-1. Locations of the three long-term monitoring stations on Tellico River.

Table 2-2. Site and sampling information for Tellico River in 2001.

Location	Station 1		Station 2		Station 3	
Site Code	420012001		420012002		420012003	
Sample Date	16 October		16 October		18 October	
Watershed	Tellico/Little Tennessee		Tellico/Little Tennessee		Tellico/Little Tennessee	
County	Monroe		Monroe		Monroe	
Quadrangle	Big Junction 140 SE		Big Junction 140 SE		Big Junction 140 SE	
Lat-Long	351831N-840723W		351722N-840615W		351644N-840545W	
Reach Number	06010204-13,1		06010204-13,1		06010204-13,1	
Elevation (ft)	1,880		1,980		2,225	
Stream Order	~4		~4		~4	
Land Ownership	USFS		USFS		USFS	
Fishing Access	Excellent		Excellent		Excellent	
Description	Begins ~400 m upstream of the Green Cove Br. confluence.		Ends a short distance below a large island just downstream of hatchery		Begins at upper end of Davis Br. campground.	
Effort						
Station Length (m)	175		134		205	
Sample Area (m²)	2,485		1,822		2,235	
Personnel	14		14		11	
Electrofishing Units	5		4		4	
Voltage (AC)	500		500		600	
Removal Passes	3		3		3	
Habitat						
Mean width (m)	14.2		13.6		10.9	
Maximum depth (cm)	120		108		125	
Canopy cover (%)	15		40		50	
Aquatic vegetation	scarce		scarce		scarce	
Estimated % of site in pools	44		54		51	
Estimated % of site in riffles	56		46		49	
Visual Hab. Assess. Score	159 (suboptimal)		157 (suboptimal)		151 (suboptimal)	
Substrate Composition	Pool (%)	Riffle (%)	Pool (%)	Riffle (%)	Pool (%)	Riffle (%)
Silt	5		5		5	
Sand	10	5	10	5	20	5
Gravel	15	25	10	30	5	20
Rubble	35	40	30	30	10	20
Boulder	15	25	30	25	30	50
Bedrock	20	5	15	10	30	5
Water Quality						
Flow (cfs; visual)	40.1; normal		30.5; normal		22.0; normal	
Temperature (C)	11.5		10.8		7.6	
pH	6.9		6.8		6.8	
Conductivity (uS/cm)	15		15		14	
Dissolved Oxygen (mg/L)	9.8		9.8		11.1	
Alkalinity (mg/L $CaCO_3$)	10		10		10	

Table 2-3. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for three stations on Tellico River sampled 16 and 18 October 2001.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Biomass (g)	Mean Fish Wt. (g)	Standing Crop (kg/ha) Est.	Standing Crop (kg/ha) Lower C.L.	Standing Crop (kg/ha) Upper C.L.	Density (Fish/ha) Est.	Density (Fish/ha) Lower C.L.	Density (Fish/ha) Upper C.L.
Station 1												
RBT <90 mm	37	48	37	69	304	6.3	1.22	0.94	1.75	193	149	278
RBT >90 mm	96	102	96	110	2,747	26.9	11.05	10.39	11.91	410	386	443
BNT <90 mm	1	1	1	1	9	9.0	0.04	0.04	0.04	4	4	4
BNT >90 mm	102	115	102	129	3,418	29.7	13.75	12.19	15.42	463	410	519
Blacknose dace	429	499	463	535	1,820	3.6	7.32	6.71	7.75	2,008	1,863	2,153
Creek chub	43	44	43	48	214	4.9	0.86	0.85	0.95	177	173	193
River chub	1	1	1	1	4	4.0	0.02	0.02	0.02	4	4	4
Rosyside dace	137	188	139	237	501	2.7	2.02	1.51	2.58	757	559	954
C. stoneroller	7	7	7	8	145	20.7	0.58	0.58	0.67	28	28	32
Fantail darter	208	328	226	430	1,068	3.3	4.30	3.00	5.71	1,320	909	1,730
N. hogsucker	144	153	144	163	6,577	43.0	26.47	24.92	28.21	616	579	656
Totals	**1,205**	**1,486**	**1,259**	**1,731**	**16,807**		**67.63**	**61.15**	**75.01**	**5,980**	**5,064**	**6,966**
Station 2												
RBT <90 mm	1	1	1	1	6	6.0	0.03	0.03	0.03	5	5	5
RBT >90 mm	76	86	76	99	3,094	36.0	16.98	15.02	19.56	472	417	543
BNT >90 mm	37	39	37	44	2,403	61.6	13.19	12.51	14.88	214	203	241
Blacknose dace	231	296	250	342	1,230	4.2	6.75	5.76	7.88	1,625	1,372	1,877
Creek chub	19	20	19	24	84	4.2	0.46	0.44	0.55	110	104	132
River chub[1]	11	17	--	--	100	5.9	0.55	--	--	93	--	--
Rosyside dace	70	77	70	87	391	5.1	2.15	1.96	2.44	423	384	477
C. stoneroller	15	15	15	16	274	18.3	1.50	1.51	1.61	82	82	88
N. hog sucker	73	78	73	86	3,670	47.1	20.14	18.87	22.23	428	401	472
Totals	**533**	**629**	**541**	**699**	**11,252**		**61.75**	**56.10**	**69.18**	**3,452**	**2,968**	**3,835**
Station 3												
RBT <90 mm	83	84	83	87	572	6.8	2.56	2.53	2.65	376	371	389
RBT >90 mm	211	212	211	215	5,300	25.0	23.71	23.60	24.05	949	944	962
Blacknose dace	18	21	18	30	86	4.1	0.38	0.33	0.55	94	81	134
N. hogsucker	14	14	14	15	1,219	87.1	5.45	5.46	5.85	63	63	67
Totals	**326**	**331**	**326**	**347**	**7,177**		**32.10**	**31.92**	**33.10**	**1,482**	**1,459**	**1,552**

[1]Non-descending removal pattern. Population estimate set equal to 1.5 times total catch (95% confidence limits not calculated).

Note: RBT = rainbow trout and BNT = brown trout. River chubs (Station 2) are not included in totals for confidence limits.

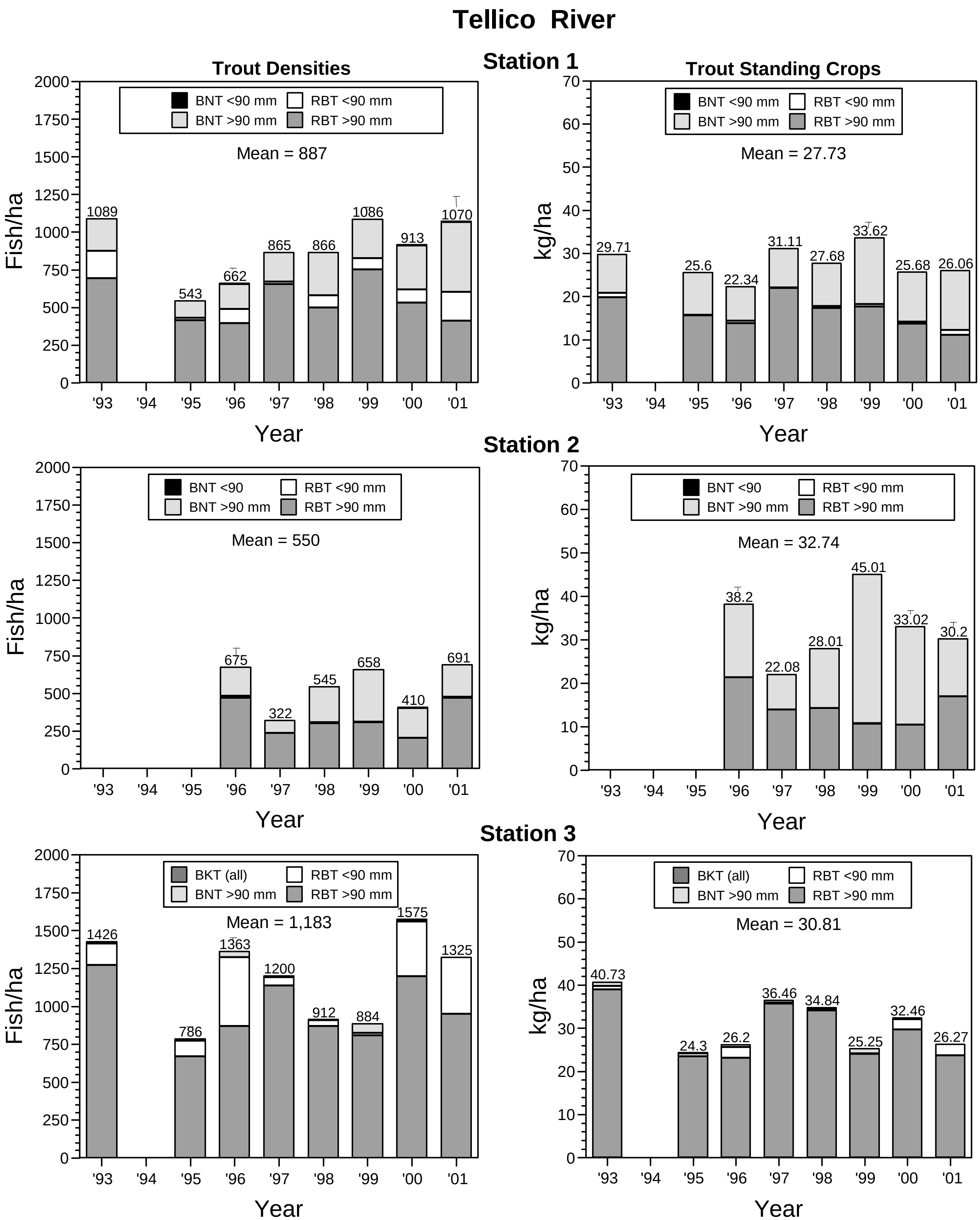


Figure 2-2. Annual (1993-2001) trout density and standing crop estimates for the three monitoring stations on Tellico River. RBT = rainbow trout, BNT = brown trout, BKT = brook trout. Bars indicate upper 95% confidence limits (overall).

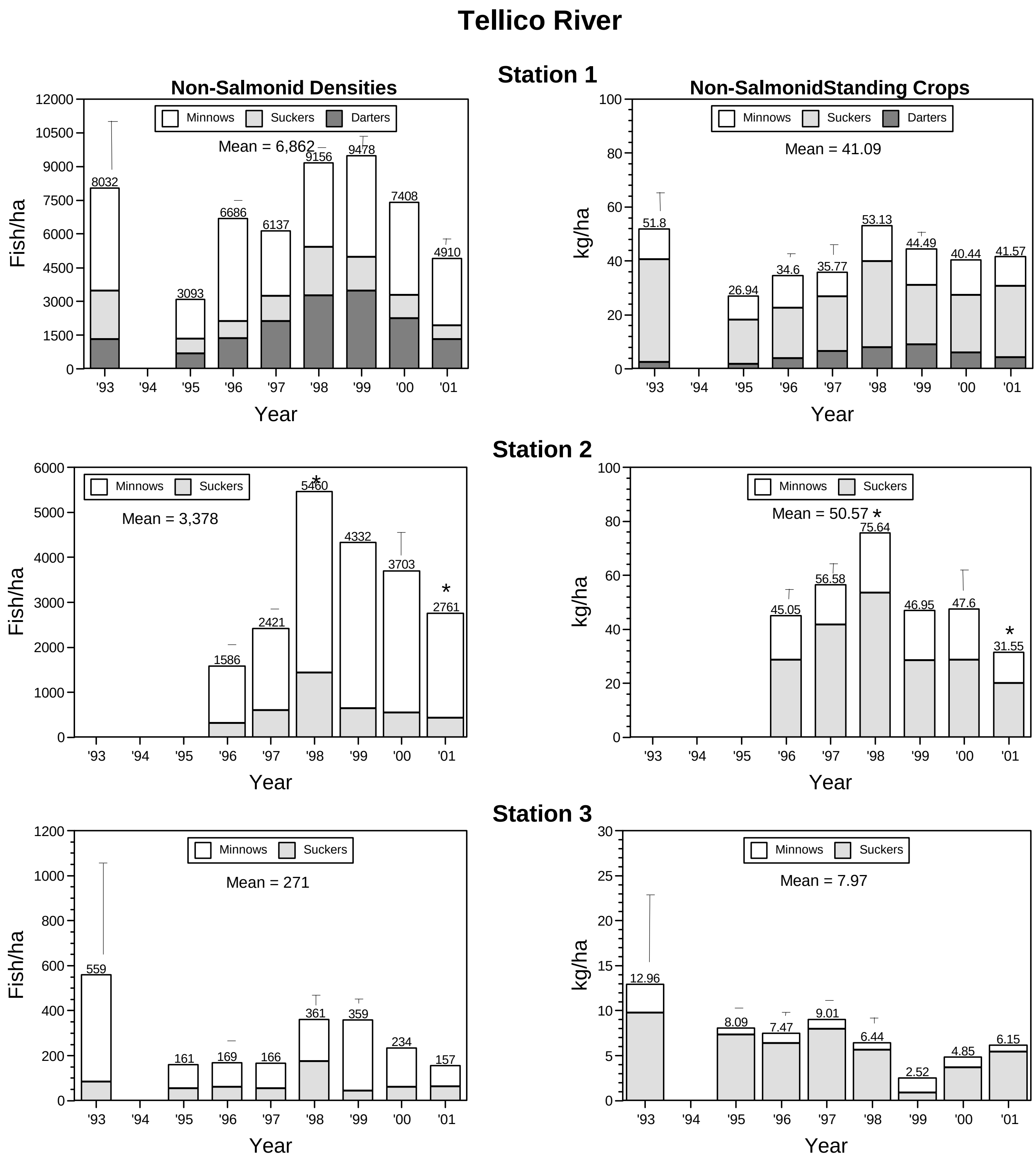


Figure 2-3. Annual (1993-2001) non-salmonid density and standing crop estimates for the three monitoring stations on Tellico River. Bars indicate upper 95% confidence limits (overall). Samples that included species with a non-descending removal pattern are designated by an asterisk (*).

Tellico River

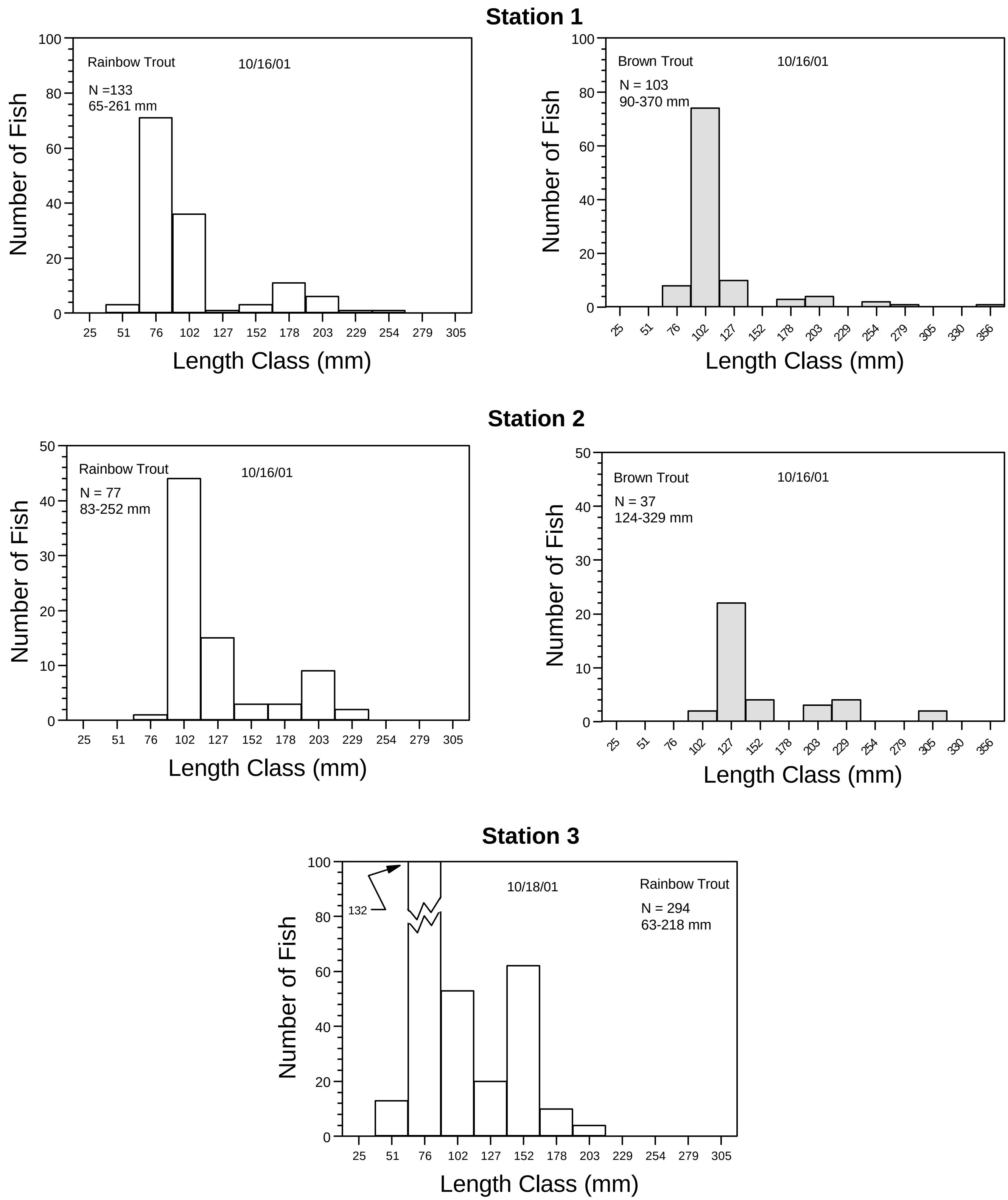
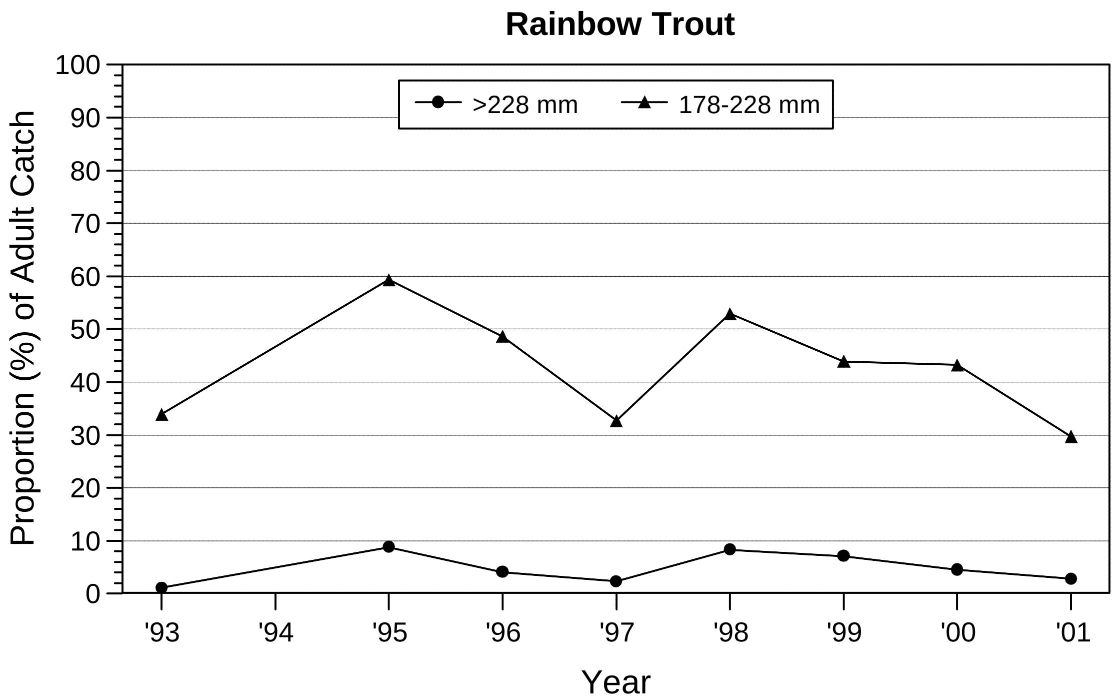


Figure 2-4. Length frequency distributions for rainbow and brown trout from the 2001 Tellico River samples. Length classes shown (mm) correspond to inch groups (1-12, rainbows; 1-14, browns).

Tellico River



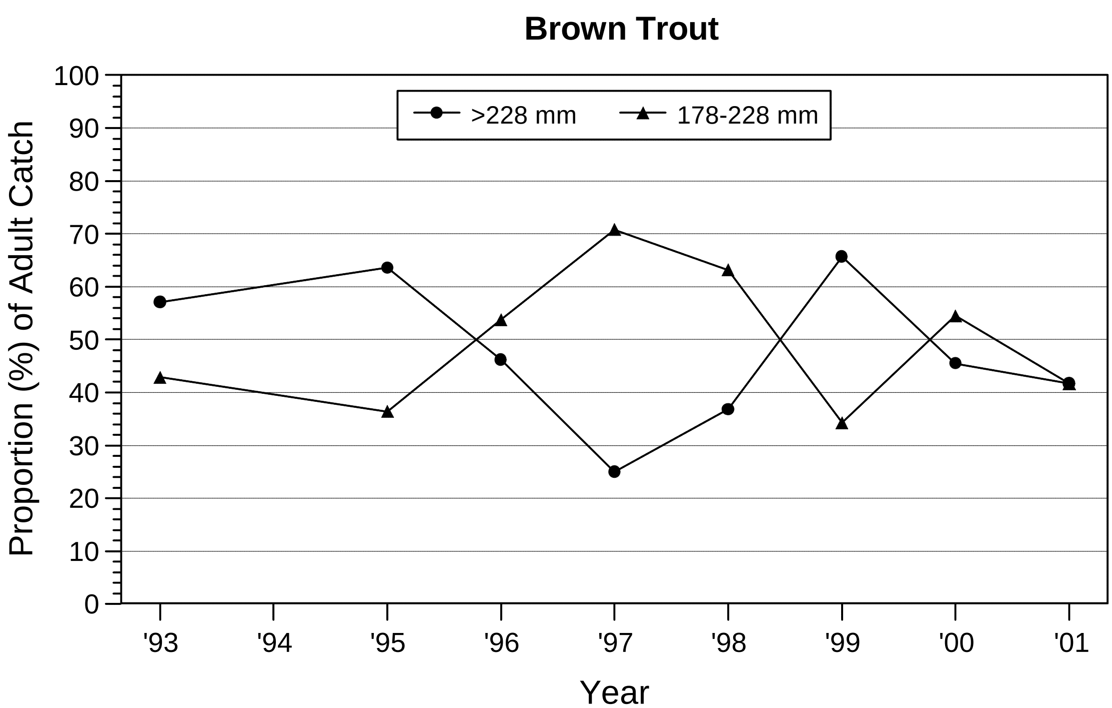


Figure 2-5. Relative abundances of larger rainbow and brown trout at the long-term monitoring stations on Tellico River.

Table 2-4. Benthic organisms sampled at Tellico River Station 1 in 2001 (Field # RDB-2001-30). Total sampling effort was 3 h.

Order	Family	*Genus / species*	Number	Percent
ANNELIDA				0.2
	Oligochaeta		1	
COLEOPTERA				6.5
	Dryopidae	*Helichus* adult	1	
	Elmidae	*Promoresia elegans* larvae	2	
		Promoresia tardella larvae and adults	22	
	Psephenidae	*Psephenus herricki*	8	
DIPTERA				7.9
	Athericidae	*Atherix lantha*	3	
	Ceratopogonidae	*Palpomyia* complex	3	
	Chironomidae		12	
		Stempellina	1	
	Simuliidae		17	
	Tipulidae	*Hexatoma*	1	
		Tipula	3	
EPHEMEROPTERA				18.8
	Baetidae	*Baetis*	68	
	Ephemerellidae	*Ephemerella*	5	
		Eurylophella	2	
	Ephemeridae	*Ephemera*	2	
	Heptageniidae	*Leucrocuta*	1	
		Stenacron	2	
		Stenonema	3	
	Leptophlebiidae	*Paraleptophlebia*	8	
	Neoephemeridae	*Neoephemera purpurea*	4	
GASTROPODA				1.6
	Ancylidae	*Ferrissia*	8	
HETEROPTERA				0.4
	Veliidae	*Rhagovelia obesa*	2	
MEGALOPTERA				0.6
	Corydalidae	*Nigronia serricornis*	3	
ODONATA				2.2
	Aeshnidae	*Boyeria grafiana*	3	
		Boyeria vinosa	1	
	Calopterygidae	*Calopteryx*	1	
	Cordulegastridae	*Cordulegaster maculata*	3	
	Gomphidae	*Gomphurus rogersi*	2	
		Lanthus vernalis	1	
PELECYPODA				0.8
	Sphaeriidae		4	
PLECOPTERA				21.2
	Capniidae		1	
	Peltoperlidae	*Peltoperla*	37	
	Perlidae	*Acroneuria abnormis*	48	
		Paragnetina immarginata	3	
		Paragnetina media	1	
	Perlodidae	*Isoperla*	8	
	Pteronarcyidae	*Pteronarcys (Allonarcys)*	9	
TRICHOPTERA				39.6
	Apataniidae	*Apatania*	29	
	Arctopsychidae	*Arctopsyche irrorata*	4	
	Brachycentridae	*Micrasema rickeri*	43	
	Glossosomatidae	*Glossosoma*	3	
	Goeridae	*Goera fuscula*	6	
	Hydropsychidae	*Ceratopsyche alhedra*	2	
		Ceratopsyche slossonae	4	
		Ceratopsyche sparna	42	
		Cheumatopsyche	6	
	Lepidostomatidae	*Lepidostoma*	1	
	Leptoceridae	*Ceraclea*	13	
	Limnephilidae	*Pycnopsyche (scabripennis* group*)*	1	
	Philopotamidae	*Dolophilodes distinctus*	32	
	Phryganeidae	*Oligostomis pardalis*	1	
	Rhyacophilidae	*Rhyacophila fuscula*	11	
	Sericostimatidae	*Fattigia pele*	2	
TURBELLARIA			1	0.2
TOTAL			505	100.0

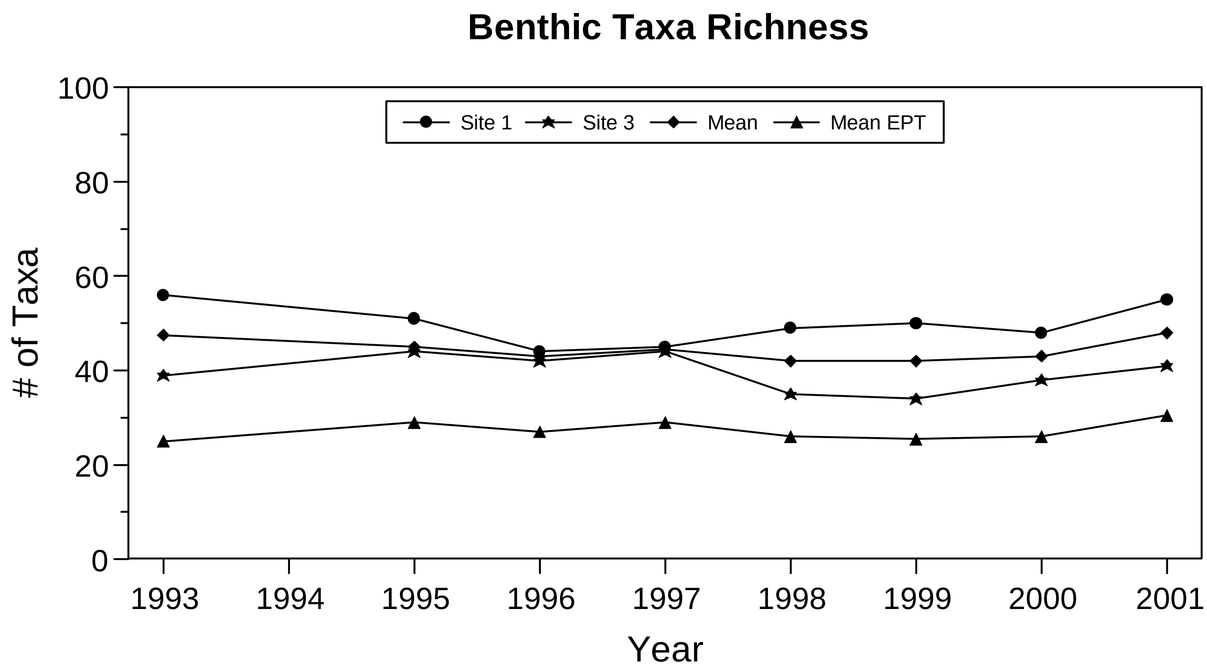
Taxa richness = 55; EPT taxa richness = 32; bioclassifiction = 4.2 (Good).

Table 2-5. Benthic organisms sampled at Tellico River Station 3 in 2001 (Field # RDB-2001-31). Total sampling effort was 3 h.

Order	Family	*Genus / species*	Number	Percent
ANNELIDA				0.5
	Oligochaeta		2	
COLEOPTERA				0.8
	Elmidae	*Promoresia tardella*	3	
DIPTERA				4.3
	Chironomidae		2	
	Dixidae	*Dixa*	1	
	Empididae		1	
	Simuliidae		12	
	Tipulidae	*Hexatoma*	1	
EPHEMEROPTERA				22.8
	Baetidae	*Baetis*	47	
	Ephemerellidae	*Ephemerella*	17	
	Ephemeridae	*Ephemera*	1	
	Heptageniidae	*Epeorus pleuralis*	1	
		Epeorus rubidus/subpallidus	2	
		Heptagenia	3	
		Stenonema	15	
	Leptophlebiidae	*Paraleptophlebia*	4	
HETEROPTERA				0.5
	Gerridae	*Gerris remigis* male and female	2	
MEGALOPTERA				1.0
	Corydalidae	*Nigronia serricornis*	4	
ODONATA				1.3
	Aeshnidae	*Boyeria grafiana*	1	
	Cordulagastridae	*Cordulagaster maculata*	2	
	Gomphidae	*Lanthus vernalis*	2	
PLECOPTERA				19.0
	Capniidae		1	
	Chloroperlidae	*Sweltsa*	5	
	Peltoperlidae	*Peltoperla*	27	
	Perlidae	*Acroneuria abnormis*	19	
		Paragnetina immarginata	13	
	Perlodidae	*Isoperla*	1	
	Pteronarcyidae	*Pteronarcys (Allonarcys)*	9	
TRICHOPTERA				49.8
	Apataniidae	*Apatania*	62	
	Glossosomatidae	*Glossosoma*	1	
	Goeridae	*Goera fuscula*	7	
	Hydropsychidae	*Arctopsyche irrorata*	15	
		Ceratopsyche alhedra	7	
		Ceratopsyche slossonae	45	
		Ceratopsyche sparna	29	
		Cheumatopsyche	4	
		Diplectrona modesta	6	
	Leptoceridae	*Ceraclea*	5	
	Philopotamidae	*Dolophilodes distinctus*	4	
	Rhyacophilidae	*Rhyacophila acutiloba*	1	
		Rhyacophila fuscula	9	
		Rhyacophila torva	1	
	TOTAL		394	100.0

Taxa richness = 41; EPT taxa richness = 29; bioclassifiction = 4.0 (Good).

Tellico River



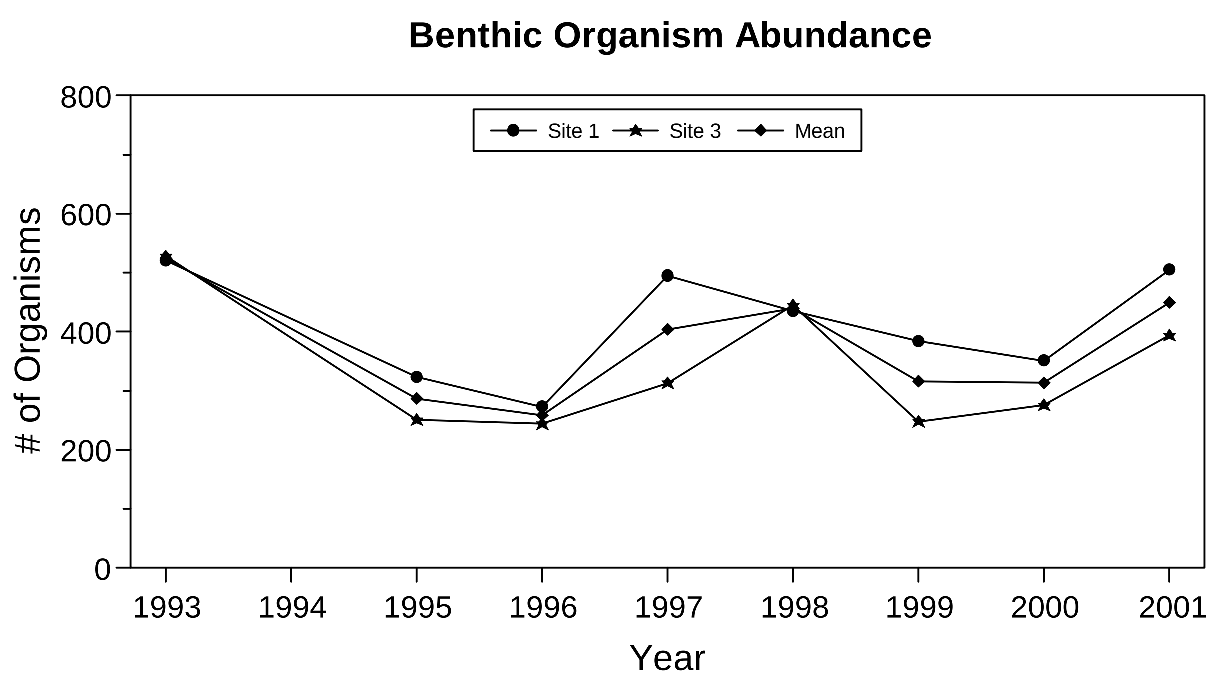


Figure 2-6. Benthic taxa richness and abundance for Tellico River during 1993-2001.

Table 2-6. Benthic organisms sampled in Tellico River immediately above the Tellico Hatchery discharge on 21 November 2001 (Field # RDB-2001-33). Total sampling effort was 3 h.

Order	Family	*Genus / species*	Number	Percent
ANNELIDA				0.7
	Branchiobdellida		1	
	Oligochaeta		2	
ARACHNOIDEA				0.2
	Hydracarina		1	
COLEOPTERA				1.8
	Elmidae	*Optioservus* larva	1	
		Optioservus ovalis adult	1	
		Promoresia elegans larvae and adults	5	
	Psepheniidae	*Psephenus herricki*	1	
COLLEMBOLA				0.4
	Isotomidae	*Isotomurus palustris*	2	
DIPTERA				12.1
	Athericidae	*Atherix lantha*	6	
	Chironomidae	larvae and pupa	31	
		Orthocladinnae sp.	1	
		Orthocladinnae/*Corynoneura*	1	
	Simuliidae		2	
	Tipulidae	*Dicranota*	10	
		Hexatoma	3	
EPHEMEROPTERA				16.6
	Baetidae	*Baetis*	4	
	Ephemerellidae	*Ephemerella*	18	
	Heptageniidae	*Epeorus dispar*	3	
		Rhithogena	5	
		Stenacron	3	
		Stenonema	17	
	Leptophlebiidae	*Paraleptophlebia*	24	
MEGALOPTERA				2.0
	Corydalidae	*Nigronia serricornis*	9	
ODONATA				0.2
	Gomphidae	*Lanthus vernalis*	1	
PLECOPTERA				26.9
	Capniidae		19	
	Chloroperlidae		7	
	Peltoperlidae	*Peltoperla*	25	
	Perlidae	*Acroneuria abnormis*	34	
		Paragnetina immarginata	6	
	Perlodidae	*Cultus*	2	
		Isoperla	10	
		Malirekus/Yugus	3	
	Pteronarcyidae	*Pteronarcys (Allonarcys)*	9	
	Taeniopteryx	*Taeniopteryx*	5	
TRICHOPTERA				39.0
	Apataniidae	*Apatania*	56	
	Brachycentridae	*Micrasema rickeri*	4	
	Glossosomatidae	*Glossosoma* pupa	1	
	Goeridae	*Goera fuscula*	4	
	Hydropsychidae	*Arctopsyche irrorata*	13	
		Ceratopsyce morosa	1	
		Ceratopsyche alhedra	5	
		Ceratopsyche slossonae	11	
		Ceratopsyche sparna	28	
		Cheumatopsyche	6	
		Diplectrona modesta	3	
	Lepidostomatidae	*Lepidostoma*	4	
	Leptoceridae	*Ceraclea*	1	
	Limnephilidae	*Pycnopsyche*	5	
	Philopotamidae	*Dolophilodes distinctus*	6	
	Polycentropodidae	*Nyctiophylax*	2	
	Rhyacophilidae	*Rhyacophila fuscula*	19	
		Rhyacophila minora	4	
	Sericostomatidae	*Fattigia pele*	1	
TOTALS			446	100.0

Taxa richness = 52; EPT taxa richness = 36; bioclassification = 4.5 (Good).

Table 2-7. Benthic organisms sampled in Tellico River immediately below the Tellico Hatchery discharge on 21 November 2001 (Field # RDB-2001-32). Total sampling effort was 3 h.

Order	Family	*Genus / species*	Number	Percent
ANNELIDA				2.7
	Oligochaeta		21	
COLEOPTERA				0.5
	Elmidae	*Optioservus* larva	1	
		Promoresia elegans larvae	2	
	Psepheniidae	*Psephenus herricki*	1	
DIPTERA				16.0
	Athericidae	*Atherix lantha*	4	
	Ceratopogonidae	*Palpomyia* complex	1	
	Chironomidae larvae and pupa		116	
	Simuliidae		1	
	Tipulidae	*Dicronota*	1	
EPHEMEROPTERA				18.8
	Baetidae	*Baetis*	16	
	Ephemerellidae	*Ephemerella*	30	
		Eurylophella	4	
	Ephemeridae	*Ephemera*	2	
	Heptageniidae	*Epeorus dispar*	1	
		Heptagenia	2	
		Stenacron	3	
		Stenonema	28	
		Stenonema pudicum	10	
	Leptophlebiidae	*Habrophlebia vibrans*	1	
		Paraleptophlebia	48	
GASTROPODA				0.3
	Ancylidae	*Ferrissia*	2	
HETEROPTERA				0.1
	Veliidae	*Rhagovelia obesa* male	1	
MEGALOPTERA				1.3
	Corydalidae	*Nigronia serricornis*	10	
ODONATA				0.9
	Aeshnidae	*Boyeria grafiana*	2	
	Cordulegastridae	*Cordulegaster maculata*	2	
	Gomphidae	*Gomphurus rogersi*	1	
		Lanthus vernalis	2	
PELECYPODA				0.3
	Sphaeriidae		2	
PLECOPTERA				23.0
	Capniidae		12	
	Chloroperlidae		4	
	Leuctridae	*Leuctra*	7	
	Peltoperlidae	*Peltoperla*	57	
	Perlidae	*Acroneuria abnormis*	35	
		Paragnetina immarginata	14	
	Perlodidae	*Diploperla*	2	
		Isoperla	33	
	Pteronarcyidae	*Pteronarcys (Allonarcys)*	6	
	Taeniopteryx	*Taeniopteryx*	7	
TRICHOPTERA				36.1
	Apataniidae	*Apatania*	56	
	Brachycentridae	*Micrasema rickeri*	2	
	Glossosomatidae	*Glossosoma*	1	
	Hydropsychidae	*Arctopsyche irrorata*	17	
		Ceratopsyche alhedra	5	
		Ceratopsyche slossonae	23	
		Ceratopsyche sparna	78	
		Cheumatopsyche	37	
	Lepidostomatidae	*Lepidostoma*	2	
	Leptoceridae	*Ceraclea*	2	
	Limnephilidae	*Pycnopsyche*	11	
	Philopotamidae	*Dolophilodes distinctus* larvae & pupa	8	
	Polycentropodidae	*Nyctiophylax*	2	
		Polycentropus	2	
	Rhyacophilidae	*Rhyacophila fuscula*	30	
		Rhyacophila minora	1	
		Rhyacophila torva pupa	1	
TOTALS			770	100.0

Taxa richness = 54; EPT taxa richness = 27; bioclassification = 4.0 (Good).

Tellico River
Hatchery Discharge Vicinity

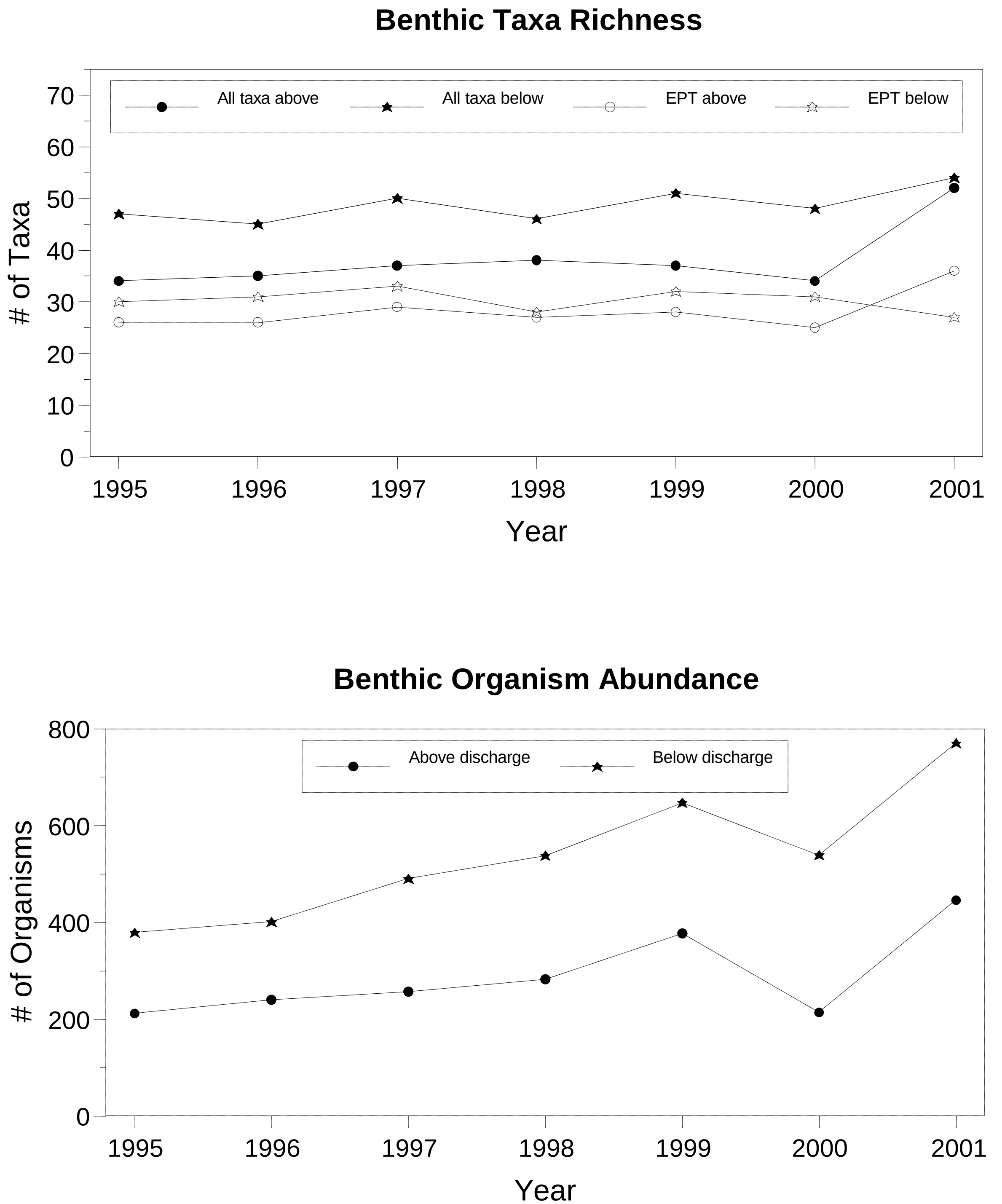


Figure 2-7. Benthic taxa richness and abundance for Tellico River near the hatchery (1995-2001).

2.2.2 North River

Study Area

North River is a Tellico River tributary in the CNF (Tellico Wildlife Management Area) in Monroe County. A gravel road (FR 217) parallels the stream for nearly its entire length and provides excellent access for anglers, but also provides a substantial amount of sediment that is carried into the stream by runoff. North River supports populations of wild rainbow and brown trout. Much of Sugar Cove Branch and nearly all of Meadow Branch, which form North River at their confluence, now contain allopatric brook trout populations. Other North River tributaries supporting brook trout are Big Cove Branch and Roaring Branch, but all populations in the watershed are descended from northern (hatchery) stocks (Strange and Habera 1997).

Shields (1951) noted good to excellent populations of stream-reared rainbow trout in North River and judged that it was becoming one of the best streams of the Tellico area. However, management at that time emphasized a put-and-take fishery and the stream was heavily stocked. In 1970, North River was officially designated as a wild trout stream subject to a three-fish creel limit, a 229-mm minimum size limit, and a single-hook, artificial-lures-only gear restriction (Wilkins 1978). Bates (1997) conducted a creel survey in the 6.5-km section of North River downstream of Laurel Branch in 1995 and 1996. It was estimated that this area received an average angling effort of 512 hrs/ha; anglers caught an estimated 4,658 wild trout (1.47 fish/hr) and harvested 186 fish per year (Bates 1997). Estimated angler catch exceeded the abundance of adults by a factor of 1.2, indicating a substantial recapture rate. Because of the high release rate (96%, Bates 1997), the estimated annual fishing mortality (exploitation) rate was low (4.7%, Strange and Habera 1997).

The stream was qualitatively sampled for TWRA in 1988 (Bivens 1989). Subsequently, three long-term monitoring stations (Figure 2-8) were established in 1991 and have been sampled annually since then. North River was to be replaced on the sampling schedule for 2001, but was retained to continue tracking the effects on this stream of the recent drought. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-8.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the North River stations in 2001 are given in Table 2-9. The general decline in total trout standing crop in North River during 1997-2000 appeared to end in 2001 (Figure 2-9). Total trout standing crop stabilized at Station 3, although it is at the lowest observed during the 11-year monitoring period, and began to increase at the other two stations (Figure 2-9). The extremely low flows and potentially elevated temperatures during the past three years are probably responsible for the decline.

In contrast to decreasing trout abundance in North River, non-salmonid abundance has generally increased since 1996, although the 2001 estimates were down at stations 1 and 2 (Figure 2-10). The fantail darter population at Station 1 had been increasing (as it had at Tellico River Station 1) since the 1994 flood (Figure 2-10), but has declined the last two years. However, the abundance of fantail darters remains many times higher than the pre-flood (1991-1993) average (4.3 fish/ha and 0.01 kg/ha) and no explanation is readily apparent.

Four harvestable (?229 mm) trout (three rainbows and one brown) were collected in North River in 2001 (Figure 2-11), which expands to 97 for the entire stream (10.1 km) excluding the marginal trout water in the first 0.8 km. This is an increase from 2000 (two were collected) and may represent recruitment from the strong 1999 cohorts. Age-0 rainbow and brown trout were abundant again in 2001 (Figure 2-11), indicating good reproductive success. Three brook trout were also collected during the 2001 North River sampling efforts (one at Station 2, two at Station 3). These fish were part of the 5,000 fingerlings (hatchery origin) stocked in upper North River in January 2001and were 128-151 mm in length in October.

The relative abundance of rainbow trout in the 178-228 mm size-group has varied substantially since 1991, ranging between 10% and 70% of the adult catch (Figure 2-12). It appears to be following a pattern with peaks and low points coming at 4-year intervals (Figure 2-12). North River apparently produces few larger (?229 mm) rainbow trout (or few remain in the fall). Typically, less than 5% of adult rainbow trout in North River samples have been ?229 mm and often, the proportion is near zero (Figure 2-12). Relative abundances of larger brown trout have not been tracked because of the low numbers of this species collected each year.

Mean backcalculated lengths at age and mean capture lengths for rainbow and brown trout during 1991-1997, based on scales (Strange and Habera 1998a), are given below. Total annual mortality (catch curve) was estimated to be 77% for rainbow trout; brown trout mortality has not been evaluated because of small sample sizes (Strange and Habera 1998a).

	Mean Length at Age (mm)					
	0	1	2	3	4	5
Rainbow (backcalculated)		115	163	200		
Rainbow (at capture)	95	152	187	230		
Brown (backcalculated)		123	215	291	399	448
Brown (at capture)	106	183	242	323		476

Age-0 rainbow trout were adipose clipped at each station in 1997 for future age validation purposes. Thirty-four were recaptured in 1998 at age 1 (average length, 149 mm), seven were recaptured in 1999 at age 2 (average length, 195 mm), one was recaptured in 2000 at age 3 (200 mm), and none were recaptured in 2001. Otoliths were removed from the fish recaptured in 2000 for age validation. Allowing for the small sample size of age-3 fish (and no representation from downstream sites), mean lengths at capture for known-age (clipped) rainbow trout were comparable to those based on the 1991-1997 scale analyses. The rarity of marked fish after the 1999 samples (i.e., age 3 and older) confirms the lack of older fish identified using scales and the relatively high estimated annual mortality rate. No micro-wire tagged brown trout released in 1995 as fingerlings were recaptured in 2001 and none have been recaptured since 1996. Analyses of otoliths from brown trout collected in North River during 1996 documented the presence of fish up to age 12 and the inaccuracy of scales for aging specimens beyond age 4. Rainbow trout otoliths will also be collected and analyzed to validate scale-derived age and growth characteristics.

Management Recommendations

North River supports one of the best wild trout fisheries in Tennessee south of GSMNP and should continue to be managed as such. The angling regulations currently in place can be maintained, but the 229-mm minimum size limit has any desirable effect. It is known that overall angler catch rates and release rates in North River are high (Bates 1997). However, the 1995/1996 North River creel data (Bates 1997) indicated that an average of 186 trout were harvested in the 6.5-km study area during April-August each year (mostly rainbows). Subsequent sampling at monitoring stations 1 and 2 (within the study area) indicated that an average of only 55 fish ?229 mm were present in October of 1995 and 1996. If all fish harvested were legal, then anglers removed about 77% of the trout ?229 mm during the spring and summer. North River is obviously capable of producing trout ?229 mm, but focusing harvest entirely on these fish could degrade the quality of the fishery. An alternative management option in this case would be to remove the size limit or reduce it to 178 mm (7 in.), thus spreading some of the harvest to the more abundant size groups. The creel limit could also be raised to five fish. Any additional harvest this causes would be expected to be compensatory given the high natural mortality rate of rainbow trout in North River. Harvesting some of the smaller fish might also increase production of larger rainbows by reducing competition and improving growth rates for some fish. Sampling should continue at the North River monitoring stations in 2002 to further document effects of the recent drought and the recovery of trout abundance. It will probably be necessary to stock brook trout fingerlings for another year or two, if available, to determine if they can successfully provide a new facet to the North River’s trout fishery.

North River Monitoring Stations

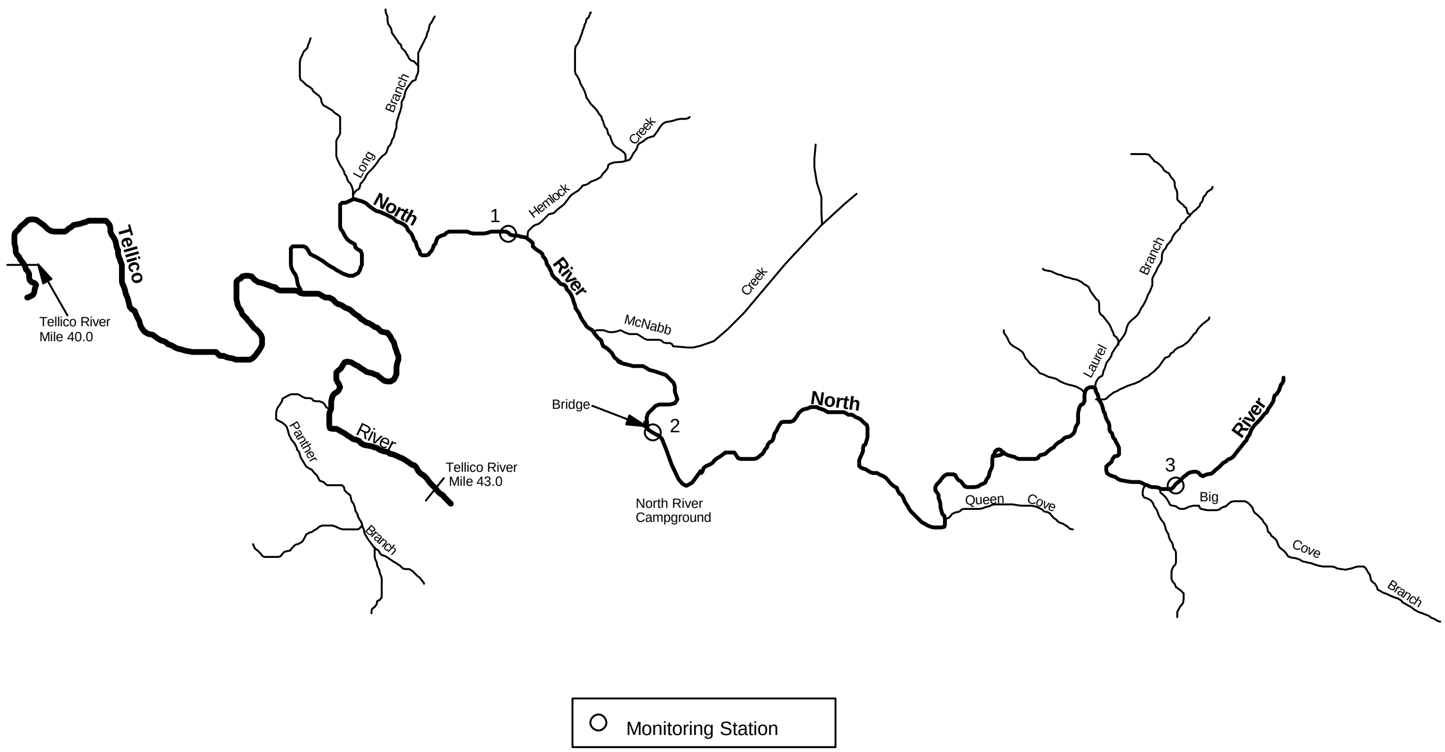


Figure 2-8. Locations of the three long-term monitoring stations on North River.

Table 2-8. Site and sampling information for North River in 2001.

Location	Station 1	Station 2	Station 3
Site Code	420012101	420012102	420012103
Sample Date	17 October	17 October	17 October
Watershed	Tellico River	Tellico River	Tellico River
County	Monroe	Monroe	Monroe
Quadrangle	Bald River Falls 140 SW	Bald River Falls 140 SW	Big Junction 140 SE
Lat-Long	351953N-840805W	351915N-840745W	351900N-840545W
Reach Number	06010204-54,0	06010204-54,0	06010204-54,0
Elevation (ft)	1,760	1,880	2,070
Stream Order	3	3	3
Land Ownership	USFS	USFS	USFS
Fishing Access	Excellent	Excellent	Excellent
Description	Site ends 100 m down-stream of Hemlock Br. confluence.	Begins ~40 m upstream of the 1st North Ri. bridge past McNabb Creek.	Begins ~20 m upstream of Big Cove Br. confl.; at ford at FR 2170 gate.
Effort			
Station Length (m)	180	136	100
Sample Area (m²)	1,566	1,537	600
Personnel	16	12	4
Electrofishing Units	4	4	2
Voltage (AC)	400	400	500
Removal Passes	3	3	3
Habitat			
Mean width (m)	8.7	10.5	6.0
Maximum depth (cm)	80	75	118
Canopy cover (%)	60	70	65
Aquatic vegetation	scarce	scarce	scarce
Estimated % of site in pools	41	65	58
Estimated % of site in riffles	59	35	42
Visual Hab. Assess. Score	152 (suboptimal)	147 (suboptimal)	161 (optimal)

Substrate Composition	Station 1 Pool (%)	Station 1 Riffle (%)	Station 2 Pool (%)	Station 2 Riffle (%)	Station 3 Pool (%)	Station 3 Riffle (%)
Silt	5		5		5	
Sand	15	10	20	20	15	5
Gravel	15	30	15	20	20	35
Rubble	30	40	25	30	35	40
Boulder	20	15	10	15	20	15
Bedrock	15	5	25	15	5	5

Water Quality	Station 1	Station 2	Station 3
Flow (cfs; visual)	14.2; normal	10.5; normal	8.5; normal
Temperature (C)	8.4	9.5	9.6
pH	6.8	6.8	6.9
Conductivity (uS/cm)	30	24	22
Dissolved Oxygen (mg/L)	10.1	10.2	10.2
Alkalinity (mg/L $CaCO_3$)	15	15	15

Table 2-9. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for three stations on North River sampled 17 October 2001.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Biomass (g)	Mean Fish Wt. (g)	Standing Crop (kg/ha) Est.	Standing Crop (kg/ha) Lower C.L.	Standing Crop (kg/ha) Upper C.L.	Density (Fish/ha) Est.	Density (Fish/ha) Lower C.L.	Density (Fish/ha) Upper C.L.
Station 1												
RBT <90 mm	53	55	53	60	357	6.5	2.28	2.20	2.49	351	338	383
RBT >90 mm	87	89	87	93	2,297	25.8	14.67	14.33	15.32	568	556	594
BNT <90 mm	2	2	2	15	16	8.0	0.10	0.10	0.77	13	13	96
Blacknose dace	280	298	284	312	812	2.7	5.19	4.90	5.38	1,903	1,814	1,992
Warpaint shiner	4	4	4	4	27	6.8	0.17	0.17	0.17	26	26	26
Saffron shiner	154	161	154	169	382	2.4	2.44	2.36	2.59	1,028	983	1,079
Creek chub	191	216	196	236	1,010	4.7	6.45	5.88	7.08	1,379	1,252	1,507
River chub	84	99	84	117	949	9.6	6.06	5.15	7.17	632	536	747
Rosyside dace	305	327	312	342	1,608	4.9	10.27	9.76	10.70	2,088	1,992	2,184
C. stoneroller	113	125	113	138	1,820	14.6	11.62	10.54	12.87	798	722	881
Fantail darter[1]	146	219	--	--	473	2.2	3.02	--	--	1,398	--	--
N. hogsucker	155	161	155	168	3,178	19.7	20.29	19.50	21.13	1,028	990	1,073
Totals	**1,574**	**1,756**	**1,444**	**1,654**	**12,929**		**82.56**	**74.89**	**85.67**	**11,212**	**9,222**	**10,562**
Station 2												
RBT <90 mm	30	38	30	55	265	7.0	1.72	1.37	2.50	247	195	358
RBT >90 mm	105	107	105	111	2,780	26.0	18.09	17.76	18.78	696	683	722
BNT <90 mm	5	5	5	5	37	7.4	0.24	0.24	0.24	33	33	33
BNT >90 mm	55	56	55	59	1,262	22.5	8.21	8.05	8.64	364	358	384
Blacknose dace	44	50	44	61	153	3.1	1.00	0.89	1.23	325	286	397
Warpaint shiner	27	28	27	32	118	4.2	0.77	0.74	0.87	182	176	208
Creek chub[1]	6	9	--	--	53	5.8	0.34	--	--	59	--	--
River chub	119	158	119	198	1,633	10.3	10.62	7.97	13.27	1,028	774	1,288
Rosyside dace	67	75	67	86	168	2.2	1.09	0.96	1.23	488	436	560
C. stoneroller	14	14	14	15	169	12.1	1.10	1.10	1.18	91	91	98
N. hog sucker	43	45	43	50	1,376	30.6	8.95	8.56	9.95	293	280	325
Totals	**515**	**585**	**509**	**672**	**8,014**		**52.13**	**47.64**	**57.89**	**3,806**	**3,312**	**4,372**
Station 3												
RBT <90 mm	44	45	44	49	344	7.6	5.73	5.57	6.21	750	733	817
RBT >90 mm	61	61	61	63	1,891	31.0	31.52	31.52	32.55	1,017	1,017	1,050
Blacknose dace	95	139	95	192	622	4.5	10.37	7.13	14.40	2,317	1,583	3,200
Totals	**200**	**245**	**200**	**304**	**2,857**		**47.62**	**44.22**	**53.16**	**4,084**	**3,333**	**5,067**

[1]Non-descending removal pattern. Population estimate set equal to 1.5 times total catch (95% confidence limits not calculated).

Note: RBT = rainbow trout and BNT = brown trout. Fantail darters (Station 1) and creek chubs (Station 2) are not included in totals for confidence limits. One brook trout (128 mm) was captured at Station 2 and two (135-151 mm) were captured at Station 3. These fish were part of 5,000 brook trout fingerlings stocked in upper North River in January 2001.

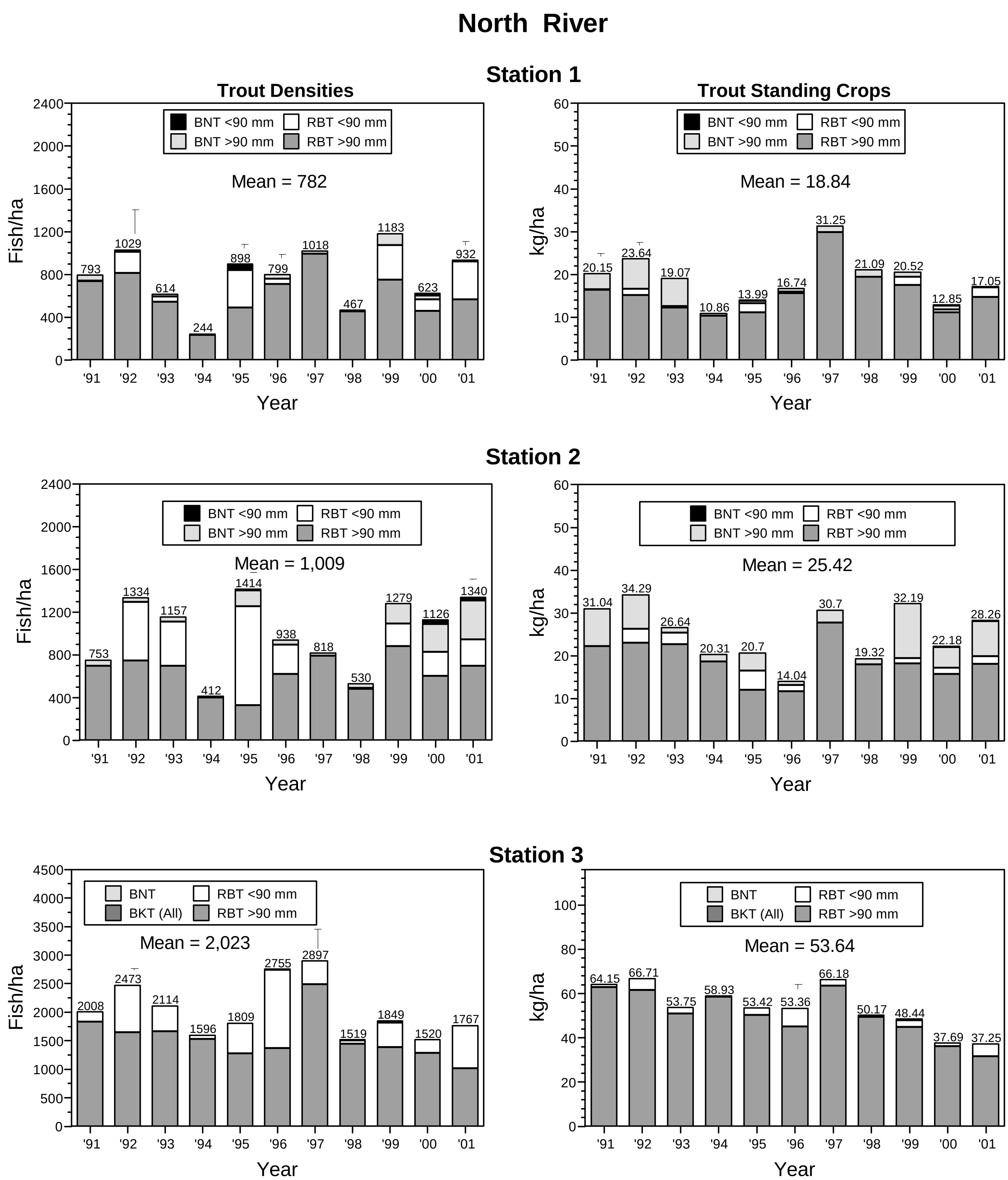


Figure 2-9. Annual (1991-2001) trout density and standing crop estimates for the three monitoring stations on North River. RBT = rainbow trout, BNT = brown trout, and BKT = brook trout. Bars indicate upper 95% confidence limits (overall).

North River

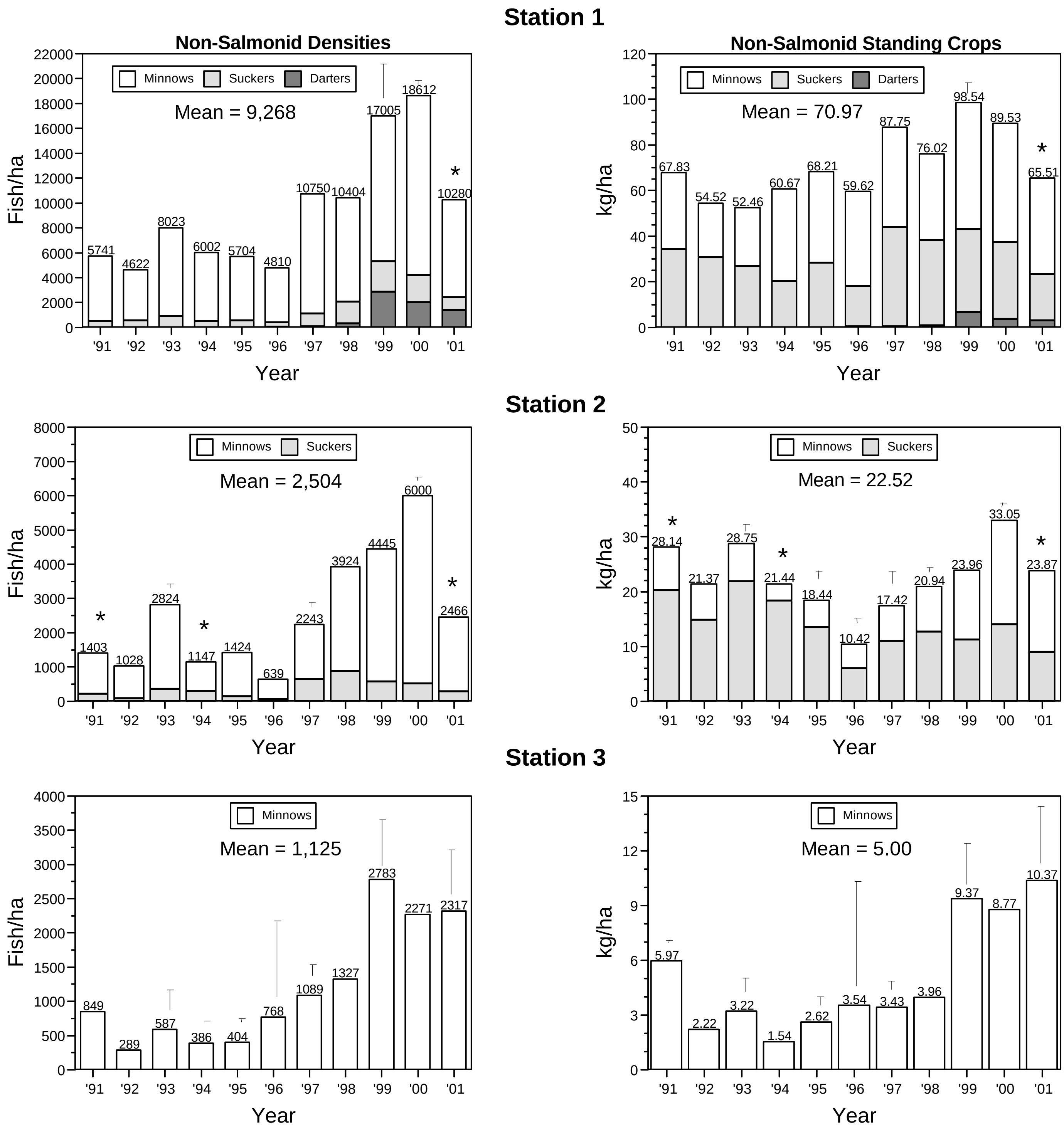
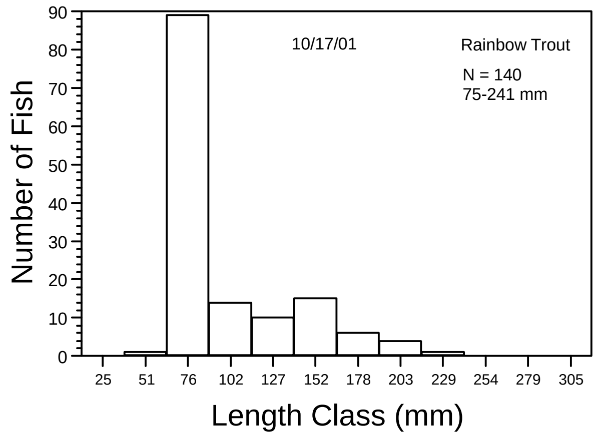
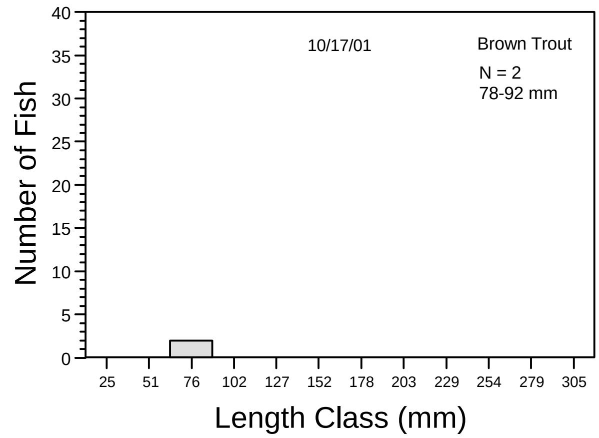


Figure 2-10. Annual (1991-2001) non-salmonid density and standing crop estimates for the three monitoring stations on North River. Bars indicate upper 95% confidence limits (overall). Samples that included species with a non-descending removal pattern are designated by an asterisk (*).

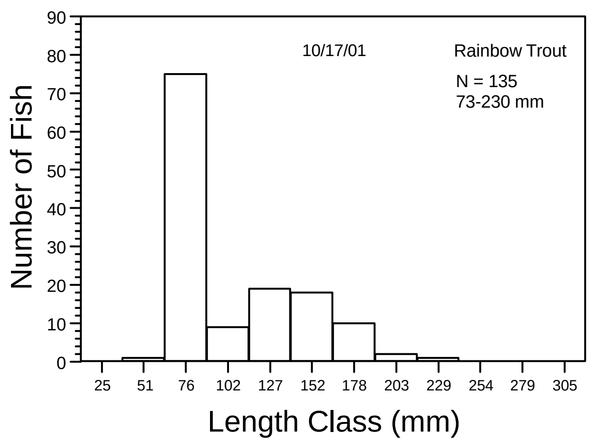
North River

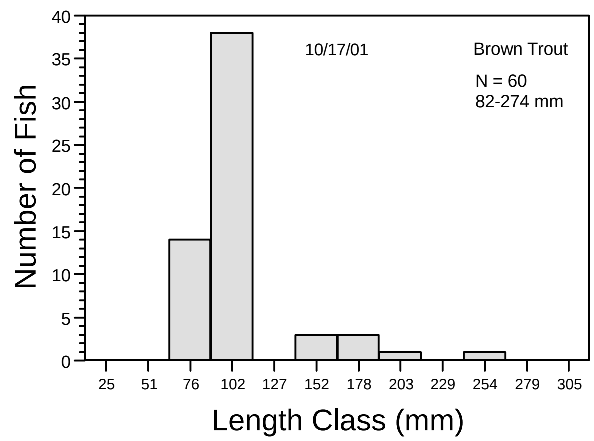
Station 1





Station 2





Station 3

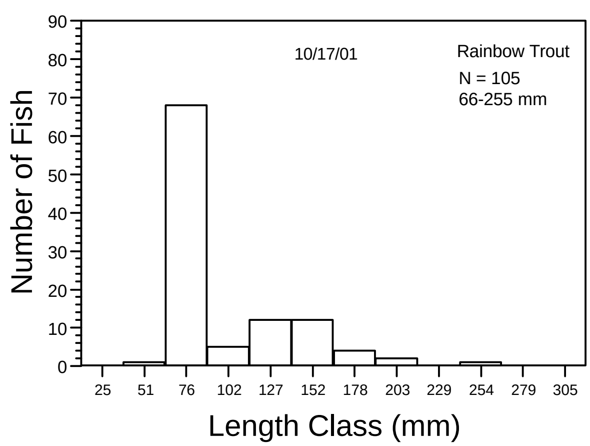


Figure 2-11. Length frequency distributions for rainbow and brown trout from the 2001 North River samples. Length classes shown (mm) correspond to inch groups (1-12).

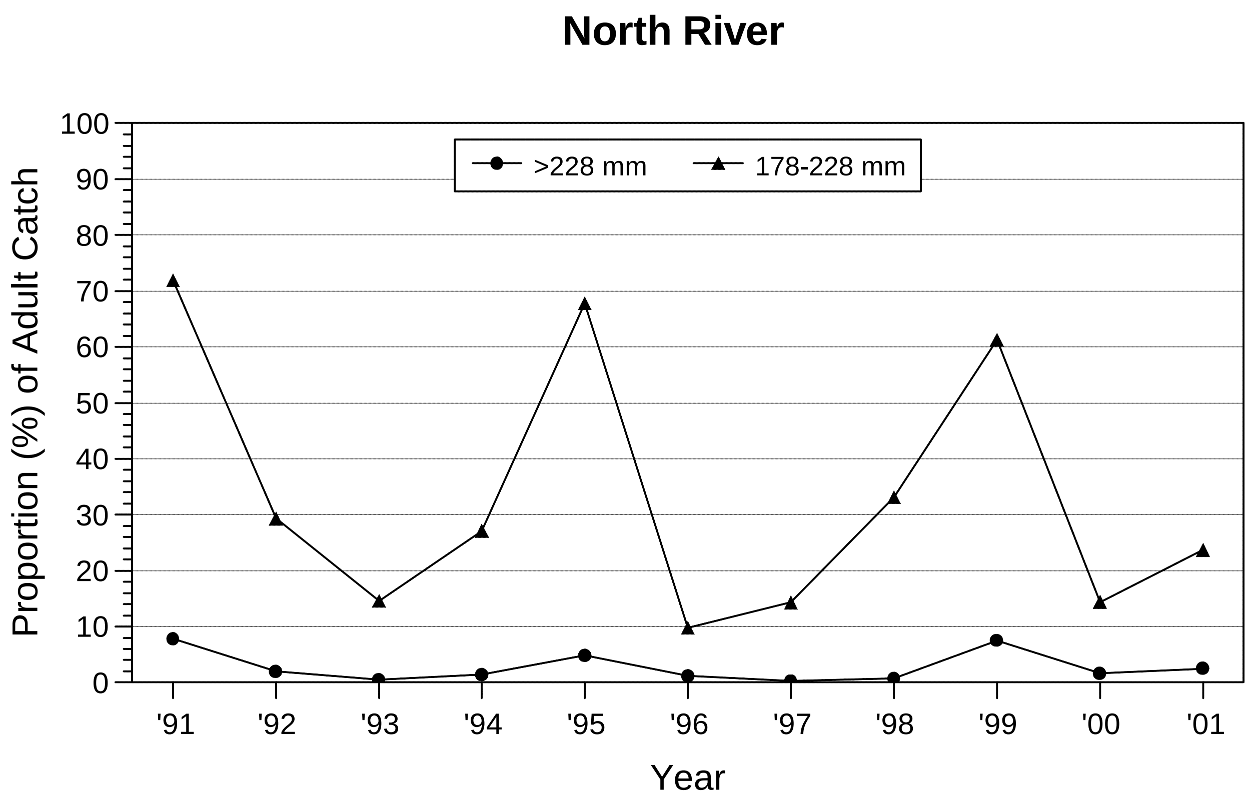


Figure 2-12. Relative abundances of larger rainbow trout at the North River long-term monitoring stations.

2.2.3 Rocky Fork

Study Area

Rocky Fork is a South Indian Creek and Nolichucky River tributary within the Rocky Fork Wildlife Management Area in Greene and Unicoi counties. The privately owned watershed is mountainous and forested, with ongoing (although relatively limited) logging activity. The middle and lower reaches of Rocky Fork support an excellent wild rainbow trout population. The upper portion of the stream (above 3,000') has both brook and rainbow trout. Three tributaries (Blockstand Creek, Broad Branch, and Fort Davie Creek) also contain brook trout, but all four populations have hybridized with hatchery fish (from northern stocks) introduced over the years (Strange and Habera 1997).

Shields (1950) noted that rainbow trout growth and production in Rocky Fork was quite good and described the portion from Fort Davie Creek downstream (12.9 km) as carrying a large crop of fish. However, the stream was intensively managed as a put-and-take fishery with hatchery-produced rainbow and brook trout for many years (Bivens et al. 1998). Management was changed in 1988 to feature the wild trout fishery. A three-fish creel limit was added to the special regulations already in place (229-mm minimum length limit and single-hook, artificial-lures only). Stocking was also discontinued except in the 1.7-km segment upstream of the confluence with South Indian Creek. Because these regulations tend to favor the harvest of brook trout over rainbow trout, which seldom exceed 229 mm (Nagel and Deaton 1989), another change was made in 1991 to focus harvest on rainbow trout in Rocky Fork and its tributaries. The size limit for rainbow trout was removed and the creel limit was raised to seven fish, of which only three can be brook trout.

Previously, Bivens (1989) and Bivens and Williams (1990) qualitatively sampled Rocky Fork. Quantitative sampling began in 1991 when two long-term monitoring stations (Figure 2-13) were established. These two stations have been sampled annually since 1991. The lower station on Rock Fork was not scheduled to be sampled in 2001, but was retained in order to continue tracking the effects on this stream of the recent drought. Site location and effort details, along with habitat and water quality information are summarized in Table 2-10.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Rocky Fork stations in 2001 are given in Table 2-11. Trout abundance, which had been declining since 1997, stabilized at Station 2 and increased at Station 1 in 2001 (Figure 2-14). Rainbow trout standing crop at Station 1 actually recovered to within 13% of the 11-year average (Figure 2-14). As in the Tellico watershed, the dry conditions prevalent during much of the past three years were probably affected trout abundance in this stream. A more detailed discussion of changes and trends in the relative abundance of brook and rainbow trout at Station 2 is provided in Section 2.3.1

Non-salmonid abundance, like trout abundance, has declined in Rocky Fork since 1997. There was, however, no stabilization or improvement in 2001 and non-salmonid abundance estimates at Station 1 in 2001 were the lowest recorded since sampling began in 1991(Table 2-14). This is opposite of the trend observed in North River, where non-salmonid abundance has typically increased as trout abundance has decreased (Section 2.2.2).

The size distribution for rainbow trout at Station 1 in 2001 was relatively well balanced except that fish in the 229-mm size class and larger were not present (Figure 2-15). However, the 2001 size distribution was typical of previous years and larger fish have never been abundant in samples from this stream. The proportion of adult rainbow trout in the 178-228 mm size group has remained between 10% and 20% since 1993, but was closer to 10% in 2001 (Figure 2-16). Fish in the 229-mm size class and larger have represented <4% of the adult catch each year, although none have been collected since 1996 (Figure 2-16). Size distributions for rainbow and brook trout at Station 2 are provided in Section 2.3.1.

Mean backcalculated lengths at age and mean capture lengths for rainbow trout during 1991-1997, based on scales (Strange and Habera 1998a), are given below. Total annual mortality (catch curve) was estimated to be 67% (Strange and Habera 1998a).

	Mean Length at Age (mm)				
	0	1	2	3	4
Rainbow (backcalculated)		92	150	184	
Rainbow (at capture)	72	132	179	216	

Management Recommendations

Rocky Fork provides a quality fishery for wild rainbow and brook trout which future management should feature. Because the stream is long (>13 km) and access to most of it is limited to foot travel, it provides an ideal setting for anglers seeking a more solitary experience. The angling regulations now in place are adequate; only protection of the resource (including water quality) is currently a priority. This property was sold recently by SF Rocky Fork Holdings, Inc. and the extent to which the new owners will develop it or permit access is unknown. The cost of leasing this wildlife management area has recently increased and TWRA has had difficulty the past two years securing sufficient funds to do this. The brook trout population in the upper portion of the stream has been relatively stable over the past several years (Strange and Habera 1998b) and requires no special attention at this time. The downstream monitoring station (Station 1) has now been sampled for 11 consecutive years and sampling there should continue in 2002 to further document recovery from the recent drought. Sampling at the upper station (Station 2) should continue as long as possible to add to our understanding of sympatric brook and rainbow trout population dynamics.

Rocky Fork Monitoring Stations

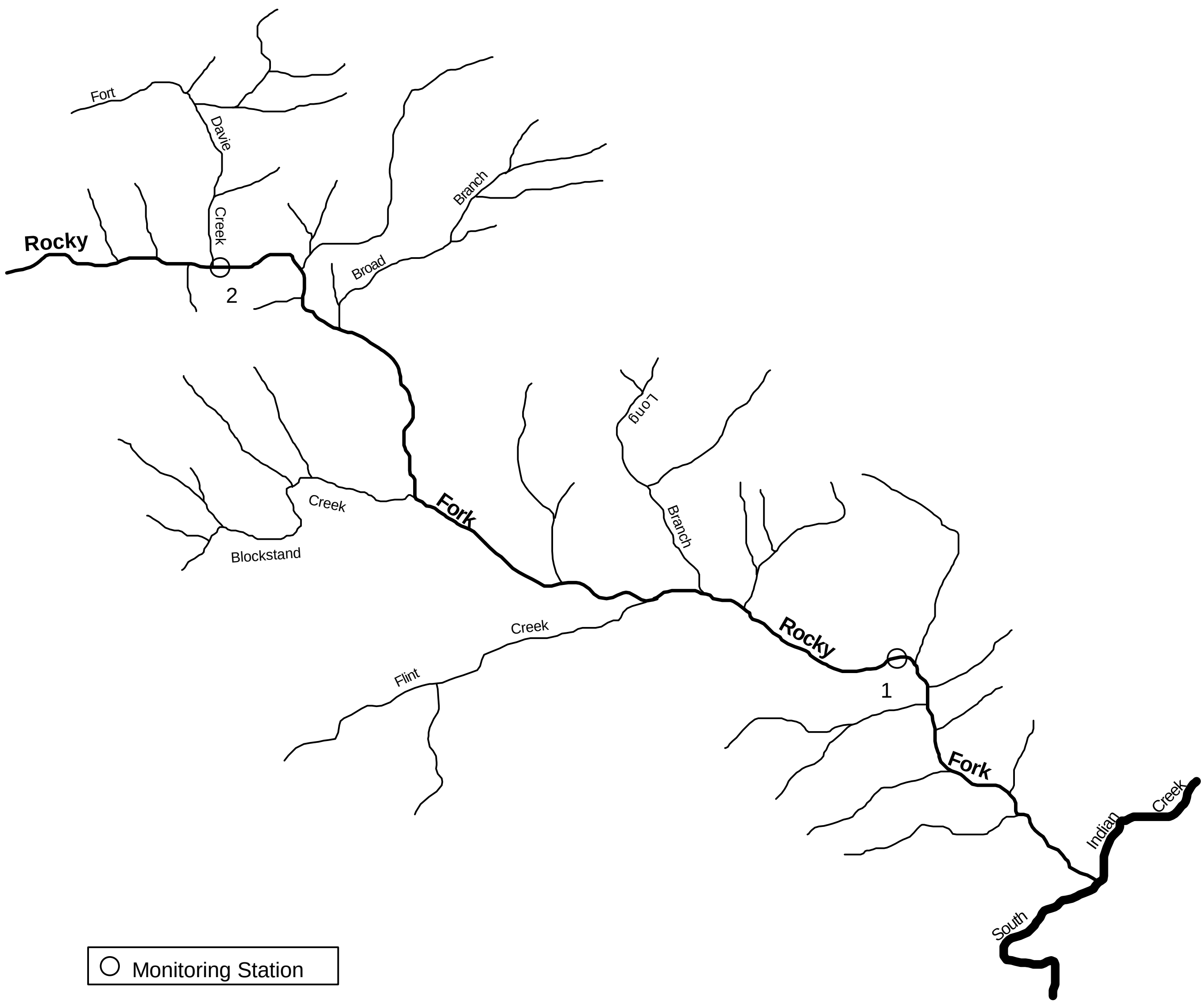


Figure 2-13. Locations of the two long-term monitoring stations on Rocky Fork.

Table 2-10. Site and sampling information for Rocky Fork in 2001.

Location	**Station 1**		**Station 2**	
Site Code	420011701		420011702	
Sample Date	12 September		12 September	
Watershed	Nolichucky River		Nolichucky River	
County	Unicoi		Greene	
Quadrangle	Flag Pond 190 SE		Flag Pond 190 SE	
Lat-Long	360252N-823330W		360403N-823545W	
Reach Number	06010108		06010108	
Elevation (ft)	2,360		3,230	
Stream Order	4		3	
Land Ownership	Private (TWRA WMA)		Private (TWRA WMA)	
Fishing Access	Good		Limited	
Description	Begins ~100 m upstream of the blue gate.		Ends ~10 m upstream of confl. with Ft. Davie Ck.	
Effort				
Station Length (m)	130		100	
Sample Area (m²)	923		460	
Personnel	9		5	
Electrofishing Units	2		1	
Voltage (AC)	500		500	
Removal Passes	3		3	
Habitat				
Mean width (m)	7.1		4.6	
Maximum depth (cm)	115		75	
Canopy cover (%)	90		95	
Aquatic vegetation	scarce		scarce	
Estimated % of site in pools	48		48	
Estimated % of site in riffles	52		52	
Visual Hab. Assess. Score	162 (optimal)		164 (optimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**	**Pool (%)**	**Riffle (%)**
Silt			5	
Sand	10		10	5
Gravel	15	25	25	35
Rubble	35	35	30	40
Boulder	10	30	25	20
Bedrock	30	10	5	
Water Quality				
Flow (cfs; visual)	11.3; normal		2.3; normal	
Temperature (C)	14.9		14.7	
pH	6.8		6.7	
Conductivity (uS/cm)	10		9	
Dissolved Oxygen (mg/L)	9.1		9.3	
Alkalinity (mg/L $CaCO_3$)	10		10	

Table 2-11. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for two stations on Rocky Fork sampled 12 September 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
Station 1												
RBT <90 mm	65	67	65	71	257	3.8	2.78	2.68	2.92	726	704	769
RBT >90 mm	105	107	105	111	3,196	29.9	34.63	34.01	35.96	1,159	1,138	1,203
Longnose dace	7	8	7	15	112	14.0	1.21	1.06	2.28	87	76	163
Blacknose dace	87	92	87	99	444	4.8	4.81	4.52	5.15	997	943	1,073
Mottled sculpin	7	8	7	15	39	4.9	0.42	0.37	0.80	87	76	163
Totals	**271**	**282**	**271**	**311**	**4,048**		**43.85**	**42.64**	**47.11**	**3,056**	**2,937**	**3,371**
Station 2												
RBT <90 mm	18	18	18	20	69	3.8	1.50	1.50	1.65	391	391	435
RBT >90 mm	11	11	11	12	500	45.5	10.87	10.87	11.87	239	239	261
BKT <90 mm	26	27	26	31	128	4.7	2.78	2.66	3.17	587	565	674
BKT >90 mm	31	31	31	33	822	26.5	17.87	17.87	19.01	674	674	717
Totals	**86**	**87**	**86**	**96**	**1,519**		**33.02**	**32.90**	**35.70**	**1,891**	**1,870**	**2,087**

Note: RBT = rainbow trout and BKT = brook trout.

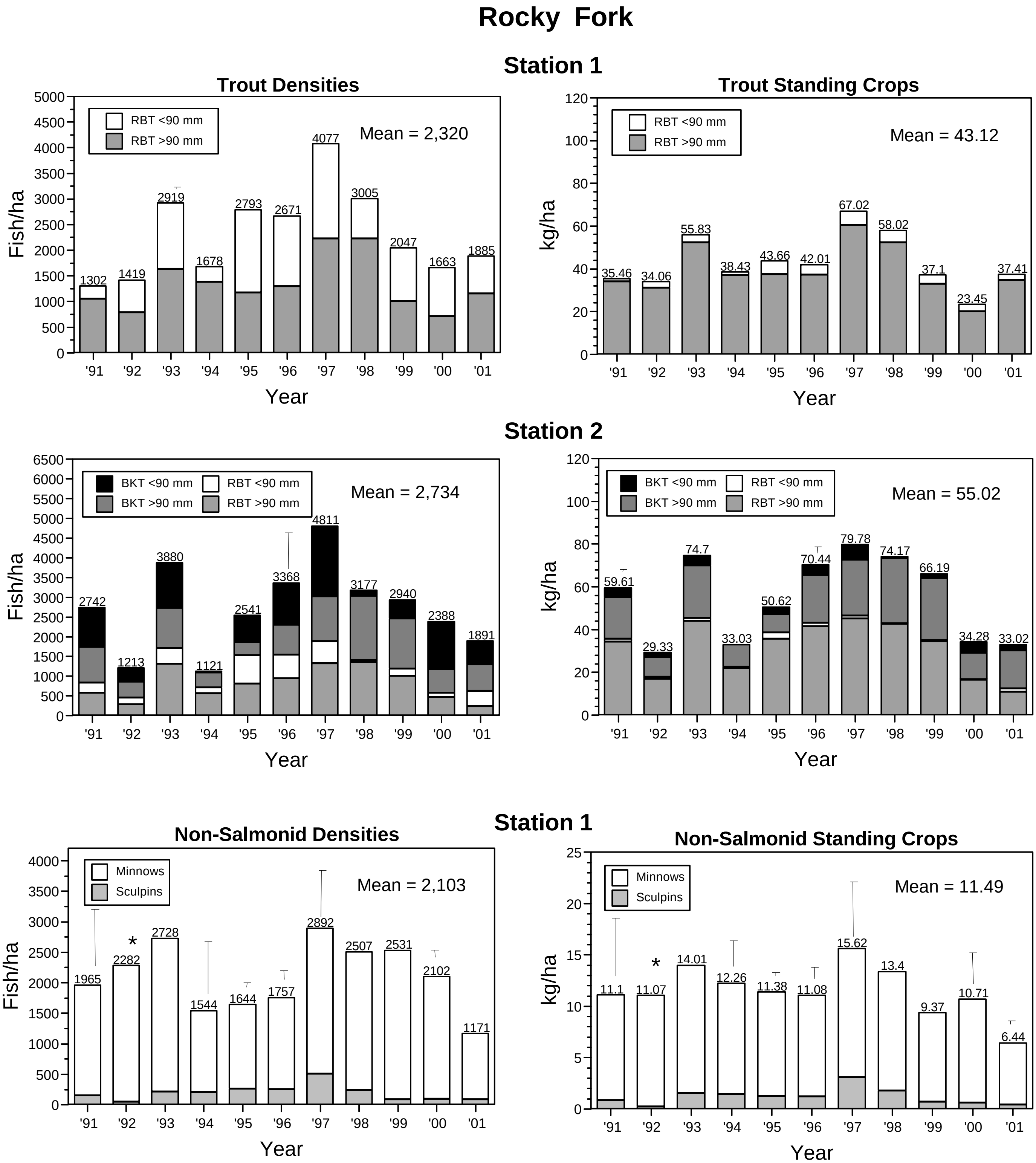


Figure 2-14. Annual (1991-2001) trout and non-salmonid density and standing crop estimates for the two monitoring stations on Rocky Fork. Bars indicate upper 95% confidence limits (overall). Samples that included species with a non-descending removal pattern are designated by an asterisk (*). RBT = rainbow trout and BKT = brook trout.

Rocky Fork

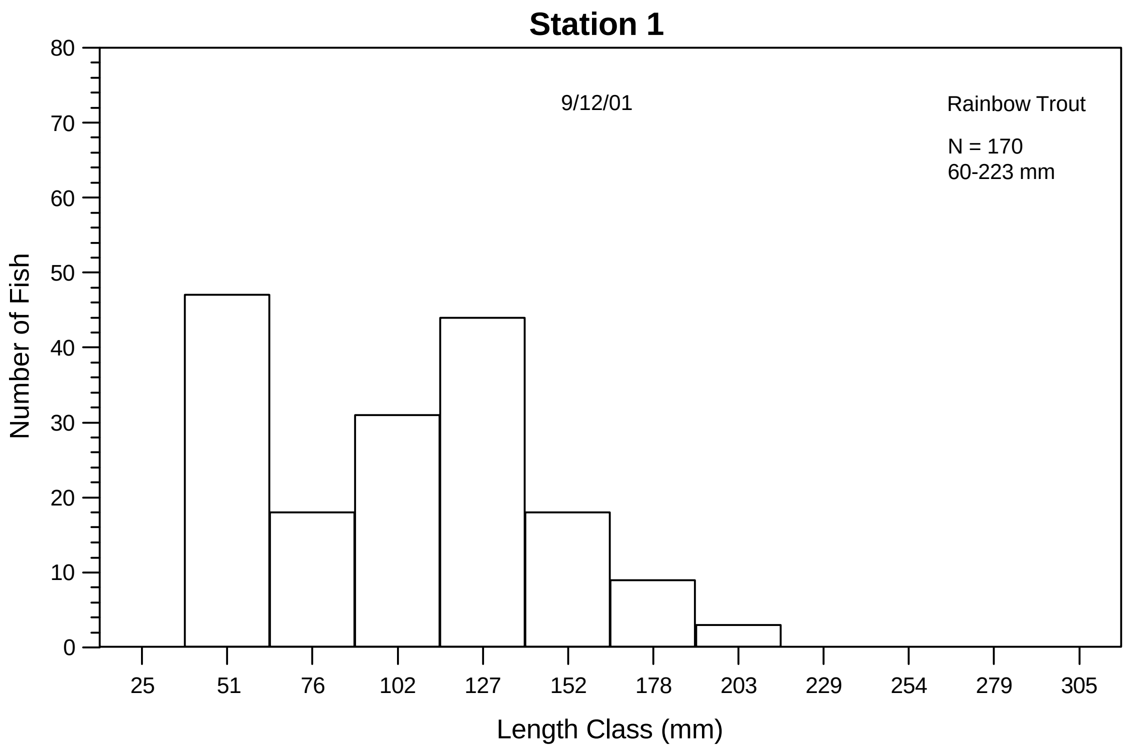


Figure 2-15. Length frequency distributions for rainbow trout from the 2001 Rocky Fork sample (Station 1). Length classes shown (mm) correspond to inch groups (1-12).

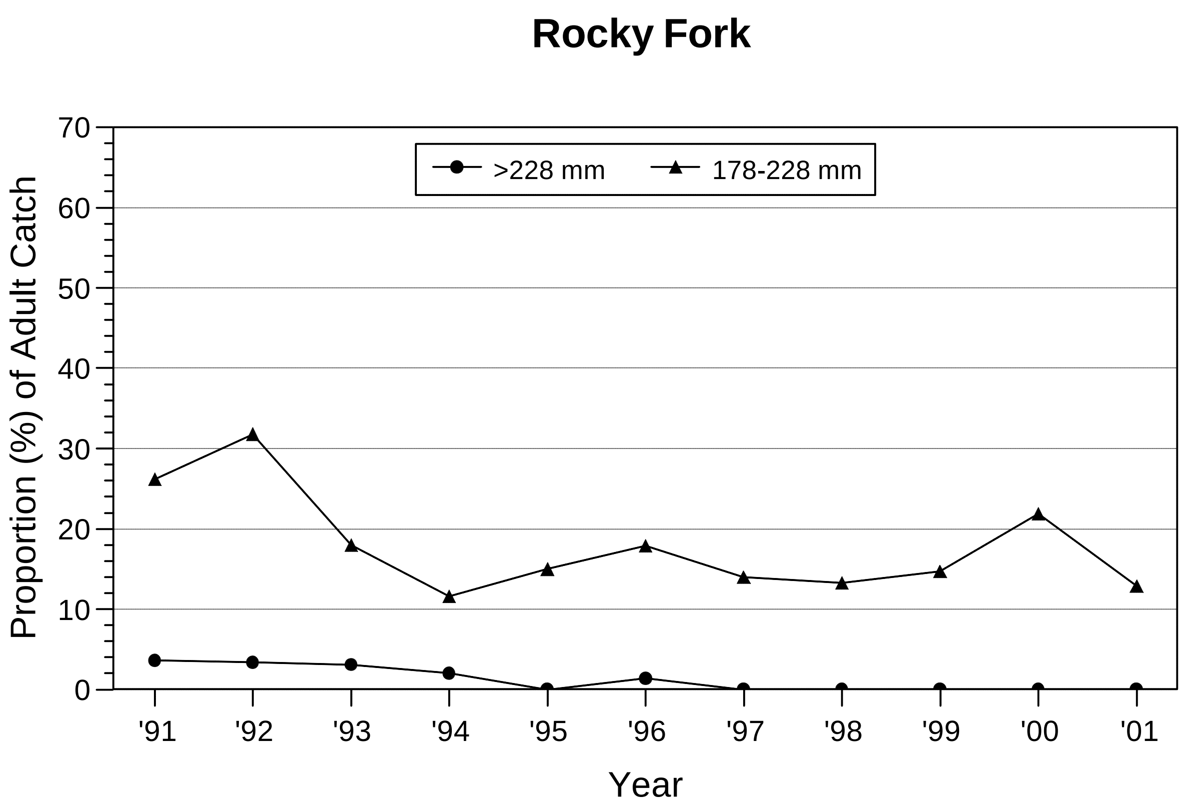


Figure 2-16. Relative abundances of larger rainbow trout at the Rocky Fork long-term monitoring stations.

2.2.4 <u>Left Prong Hampton Creek</u>

Study Area

Left Prong Hampton Creek flows through the Hampton Cove State Natural Area in Carter County and is a tributary to the Doe and Watauga rivers. The watershed is largely forested, although a substantial portion around the lower half of the stream is still in use as livestock pasture. Rhododendron (*Rhododendron* spp.) and mountain laurel (*Kalmia latifolia*), which often dominate the riparian vegetation of other wild trout stream, are absent along Left Prong Hampton Creek. Although the stream was probably inhabited by brook trout at one time, it has recently supported an exceptionally abundant population of wild rainbow trout. The stream was checked for brook trout by TWRA in 1988 (Bivens 1989) at the request of the Tennessee Department of Environment and Conservation, but none were located. A subsequent effort by Dr. Jerry Nagel (East Tennessee State University, retired) to introduce brook trout from nearby George Creek succeeded in establishing a few fish. In 1997, TWRA entered into an agreement with Trout Unlimited, the USFS, and the Southern Appalachian Highlands Conservancy to restore brook trout in the upper 2 km of Left Prong Hampton Creek. Efforts to remove rainbow trout from this area were completed in 1999 and southern Appalachian brook trout from three area streams were introduced in September that year. The creel limit for brook trout was reduced to three in 2001 to assist in the establishment of the new brook trout population.

A long-term monitoring station (Station 1) was established on lower Left Prong Hampton Creek in 1994 (Figure 2-17). Stations 2 and 3 were added in 1996 to better represent the upper portion of the stream, which has a higher gradient and more canopy cover. All three stations were sampled in 2001. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-12.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the three stations on Left Prong Hampton Creek in 2001 are given in Table 2-13. Abundance estimates at Station 1 were among the highest obtained for wild rainbow trout anywhere in Tennessee, but standing crop at this station has generally declined, particularly since 1997(Figure 2-18). The 2001 density and standing crop estimates were the lowest measured to date (Figure 2-18). Trout abundance decreases at Station 1 during the past few years are most likely related to the dry conditions that have prevailed during that time. Non-salmonid abundance at Station 1 was relatively similar to the 2000 estimates (Figure 2-18).

Brook trout in the restoration area successfully spawned again during the fall of 2000 and the new populations at stations 2 and 3 continued to expand in 2001 (Figure 2-19). Brook trout standing crop at Station 2 (23 kg/ha) has reached the statewide average for other Tennessee populations (about 21 kg/ha) and brook trout standing crop at Station 3 (40 kg/ha) is now nearly double that level (Figure 2-19). No rainbow trout were collected during the 2001 sampling efforts at stations 2 or 3. Prior to removal, rainbow trout standing crops at stations 2 and 3 averaged 78 kg/ha and 81kg/ha, respectively (Figure 2-19).

No rainbow trout in the 229-mm size class (or larger) were collected in 2000 at Station 1 (Figure 2-20), but <3% of the adult catch has included fish ?229 mm each year (Figure 2-21). Because of limited fishing pressure on this stream, it is unlikely that the lack of larger fish is a result of harvest. Another 10-25% of the adult rainbow trout catch from Left Prong Hampton Creek has been composed of fish in the 178-228 mm size range, although the relative abundance of this group has generally declined since 1997 (Figure 2-21). Overall, however, the proportions of larger fish in Left Prong Hampton Creek are generally comparable to those in other small streams.

Mean backcalculated lengths at age and mean capture lengths for rainbow trout during 1994-1997, based on scales (Strange and Habera 1998a), are given below. Total annual mortality (catch curve) was estimated to be 42% (Strange and Habera 1998a).

	Mean Length at Age (mm)					
	0	1	2	3	4	5
Rainbow (backcalculated)		87	139	176	215	261
Rainbow (at capture)	58	130	167	195	230	273

Management Recommendations

The new brook trout population in Left Prong Hampton Creek has become established and is growing exceptionally well. If brook trout abundance reaches (or even approaches) the level formerly attained by rainbow trout, Left Prong Hampton Creek would become one of Tennessee’s premier brook trout fisheries. Annual monitoring should continue in order to track development of the new brook trout population, as well as the rainbow trout abundance trend downstream. Any rainbow trout collected in the brook trout restoration zone during future monitoring efforts should be removed.

Left Prong Hampton Creek Monitoring Stations

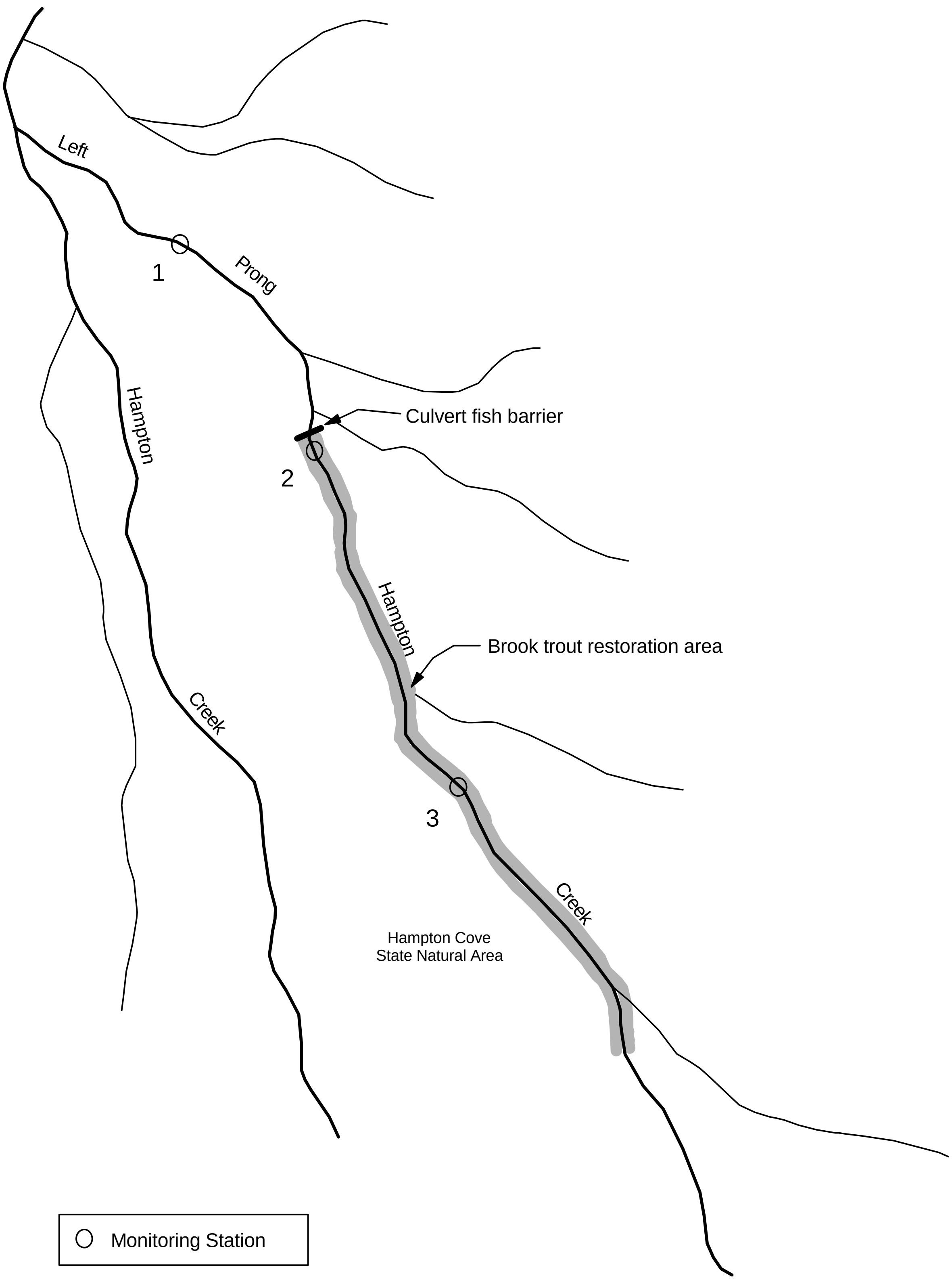


Figure 2-17. Locations of the three long-term monitoring stations on Left Prong Hampton Creek.

Table 2-12. Site and sampling information for Left Prong Hampton Creek in 2001.

Location	**Station 1**		**Station 2**		**Station 3**	
Site Code	420011101		420011102		420011103	
Sample Date	19 July		19 July		19 July	
Watershed	Watauga River		Watauga River		Watauga River	
County	Carter		Carter		Carter	
Quadrangle	White Rocks Mtn. 208 NE		White Rocks Mtn. 208 NE		White Rocks Mtn. 208 NE	
Lat-Long	360905N-820310W		360847N-820257W		360800N-820155W	
Reach Number	06010103		06010103		06010103	
Elevation (ft)	3,080		3,240		3,560	
Stream Order	2		2		2	
Land Ownership	State (Hampton Cove)		State (Hampton Cove)		State (Hampton Cove)	
Fishing Access	Limited		Limited		Limited	
Description	Begins ~10 m upstream of the first culvert.		Begins 50 m upstream of the barrier culvert.		Begins 880 m upstream of the upper end of Site 2.	
Effort						
Station Length (m)	100		94		100	
Sample Area (m²)	300		348		320	
Personnel	2		2		3	
Electrofishing Units	1		1		1	
Voltage (AC)	400		500		500	
Removal Passes	3		3		3	
Habitat						
Mean width (m)	3.0		3.7		3.2	
Maximum depth (cm)	53				70	
Canopy cover (%)	60		90		95	
Aquatic vegetation	scarce		scarce		scarce	
Estimated % of site in pools	27		40		28	
Estimated % of site in riffles	73		60		72	
Visual Hab. Assess. Score	166 (optimal)		150 (suboptimal)		154 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**				
Silt	5		5		20	
Sand	5	5	10	10	15	5
Gravel	45	35	40	25	20	30
Rubble	40	50	20	45	15	35
Boulder	5	10	25	20	25	25
Bedrock					5	5
Water Quality						
Flow (cfs; visual)	normal		normal		normal	
Temperature (C)	16.5		15.8		14.2	
pH	6.9		6.9		6.9	
Conductivity (uS/cm)	38		14		28	
Dissolved Oxygen (mg/L)	--		--		--	
Alkalinity (mg/L $CaCO_3$)	15		15		15	

Table 2-13. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for three stations on Left Prong Hampton Creek sampled 19 July 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
Station 1												
RBT <90 mm	45	64	45	97	173	2.7	5.77	4.05	8.73	2,133	1,500	3,233
RBT >90 mm	49	49	49	51	1,360	27.8	45.33	45.33	47.26	1,633	1,633	1,700
BKT <90 mm	3	3	3	3	14	4.7	0.47	0.47	0.47	100	100	100
Blacknose dace	29	36	29	51	207	5.8	6.90	5.61	9.86	1,200	967	1,700
Fantail darter	78	105	78	139	302	2.9	10.07	7.54	13.44	3,500	2,600	4,633
Totals	**204**	**257**	**204**	**341**	**2,056**		**68.54**	**63.00**	**79.76**	**8,566**	**6,800**	**11,366**
Station 2												
BKT <90 mm	83	85	83	89	240	2.8	6.90	6.68	7.16	2,443	2,385	2,557
BKT >90 mm	13	13	13	14	577	44.4	16.58	16.58	17.86	374	374	402
Blacknose dace	1	1	1	1	1	1.0	0.03	0.03	0.03	29	29	29
Totals	**97**	**99**	**97**	**104**	**818**		**23.51**	**23.29**	**25.05**	**2,846**	**2,788**	**2,988**
Station 3												
BKT <90 mm	76	78	76	82	181	2.3	5.66	5.46	5.89	2,438	2,375	2,563
BKT >90 mm	33	33	33	34	1,101	33.4	34.41	34.41	35.49	1,031	1,031	1,063
Totals	**109**	**111**	**109**	**116**	**1,282**		**40.07**	**39.87**	**41.38**	**3,469**	**3,406**	**3,626**

Note: RBT = rainbow trout and BKT = brook trout.

Left Prong Hampton Creek

Station 1

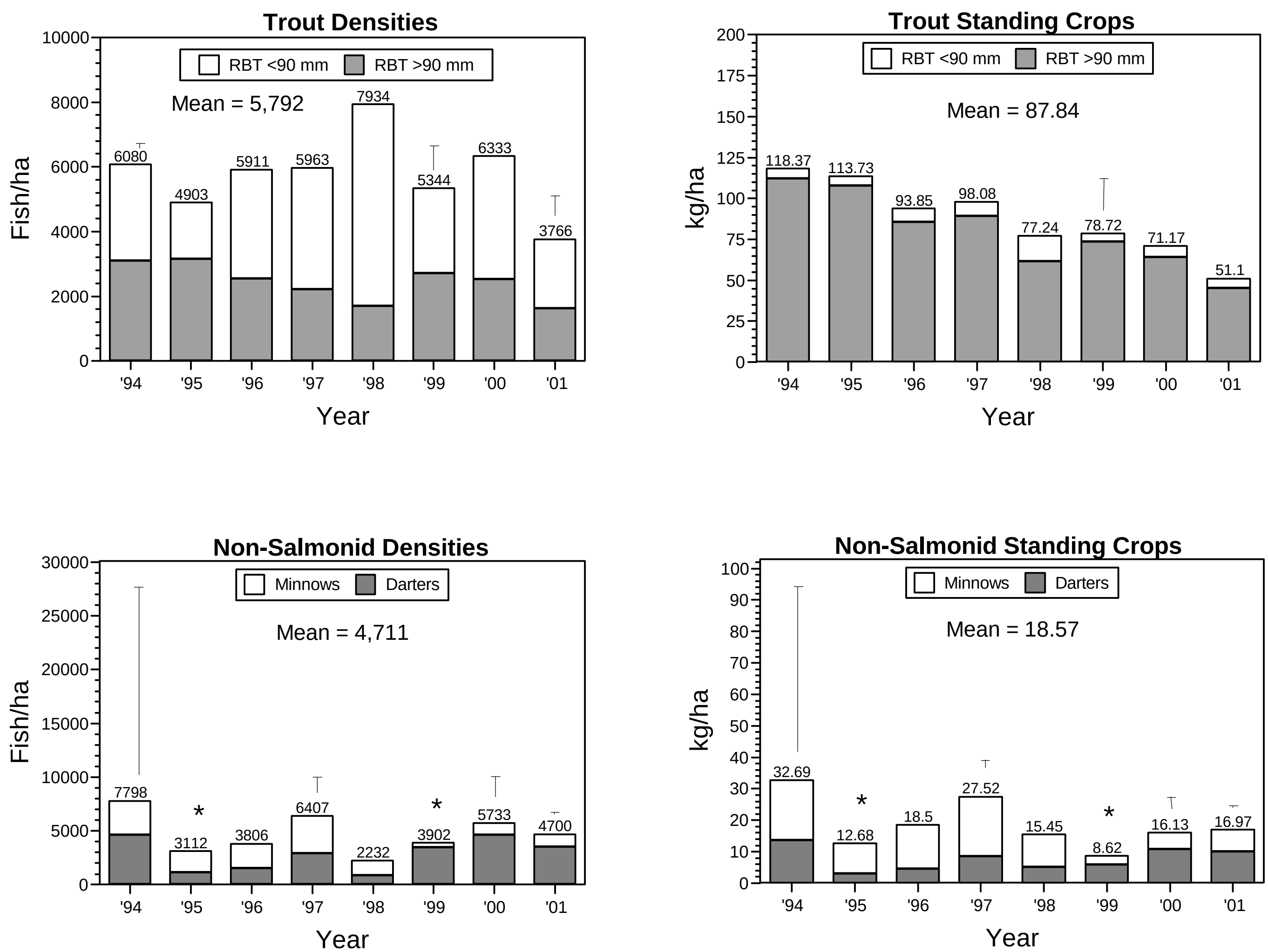


Figure 2-18. Annual (1994-2001) trout and non-salmonid density and standing crop estimates for monitoring station 1 on Left Prong Hampton Creek. RBT = rainbow trout. Bars indicate upper 95% confidence limits (overall). Samples that included species with a non-descending removal pattern are designated by an asterisk (*).

Left Prong Hampton Creek

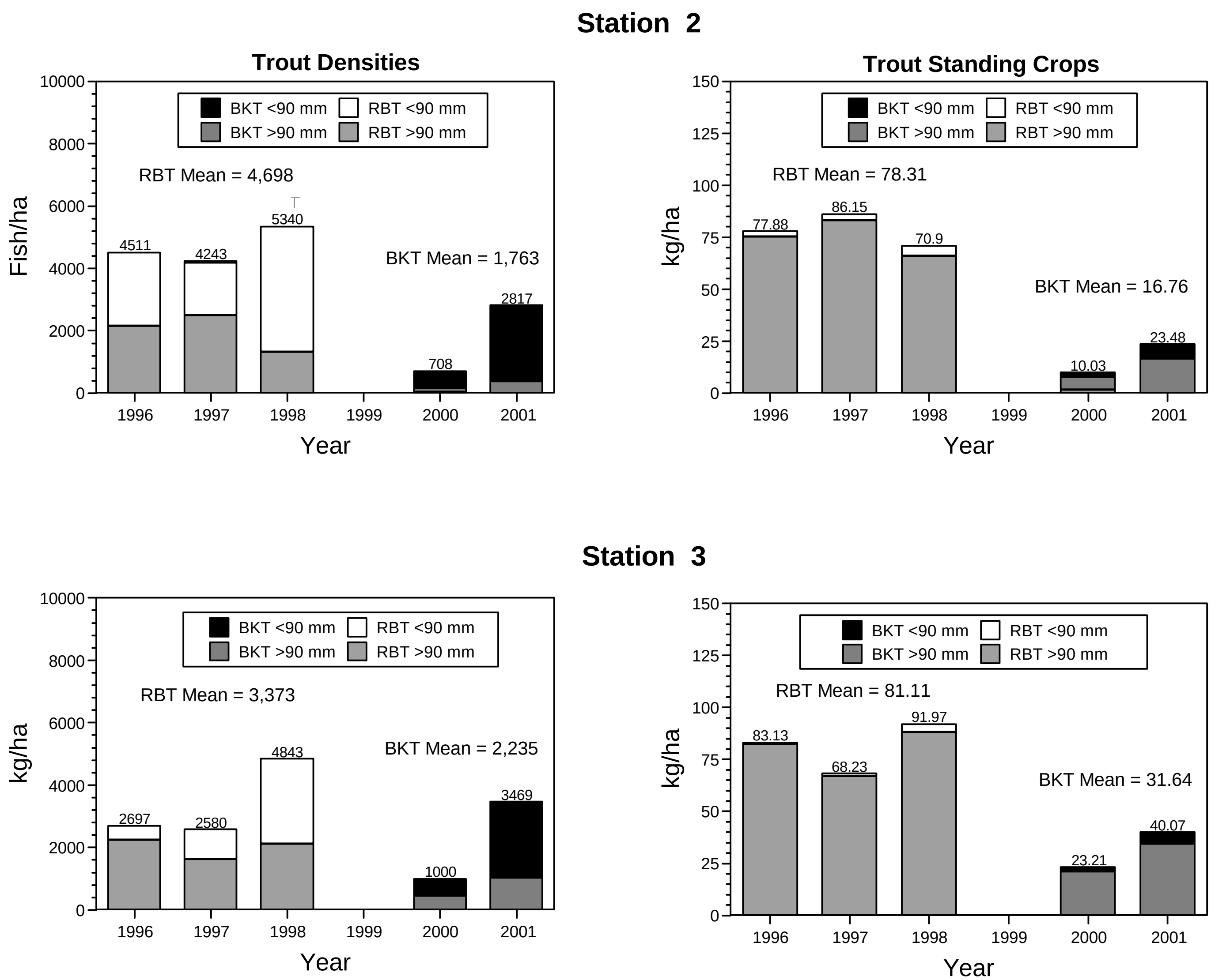


Figure 2-19. Annual (1996-2001) trout density and standing crop estimates for monitoring monitoring stations 2 and 3 on Left Prong Hampton Creek. RBT = rainbow trout and BKT = brook trout. Bars indicate upper 95% confidence limits (overall). Rainbow trout were removed by electrofishing during October 1998-September 1999. These stations were not sampled in 1999.

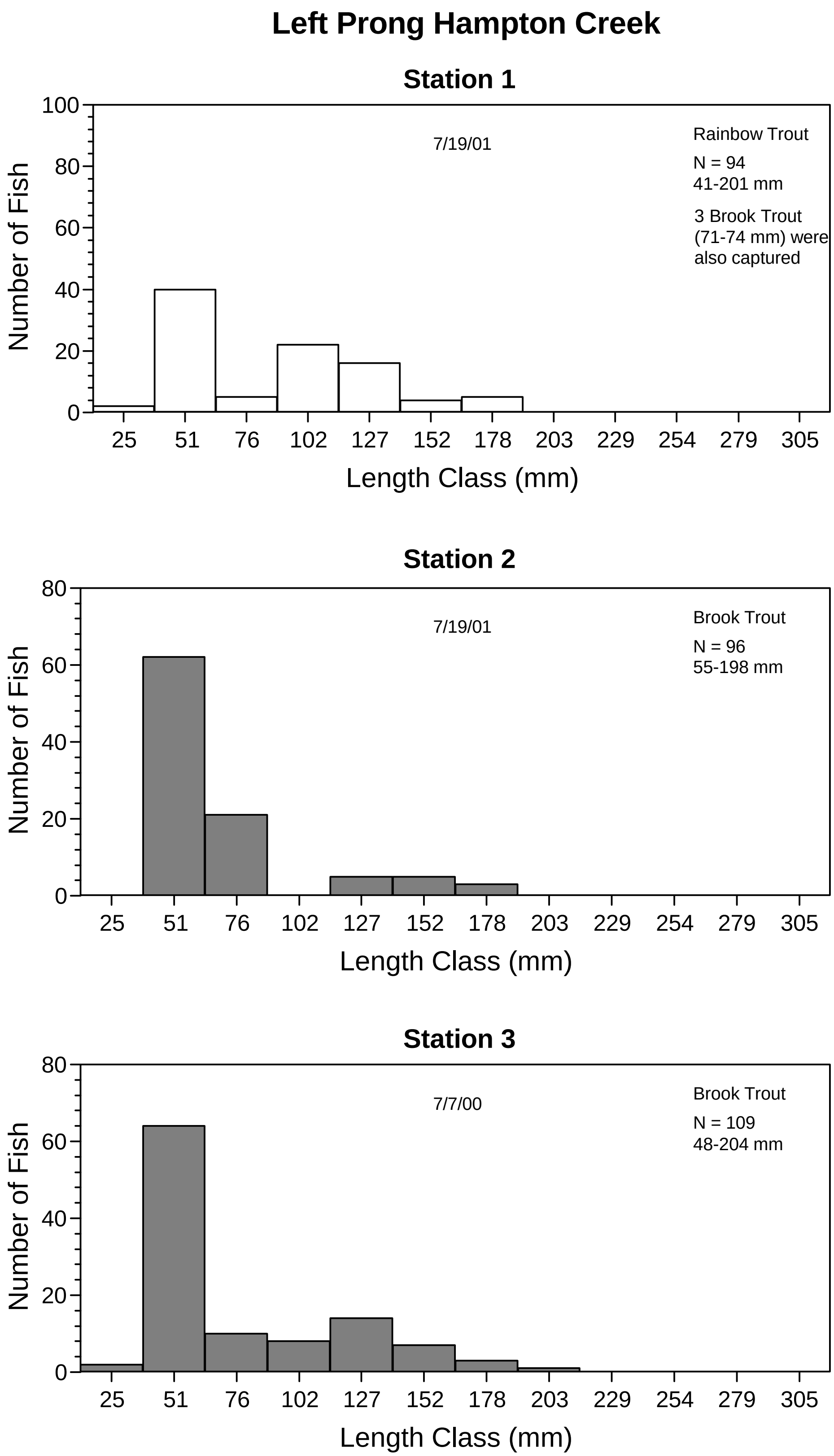


Figure 2-20. Length frequency distribution for trout from the 2001 Left Prong Hampton Creek sample. Length classes shown (mm) correspond to inch groups (1-12).

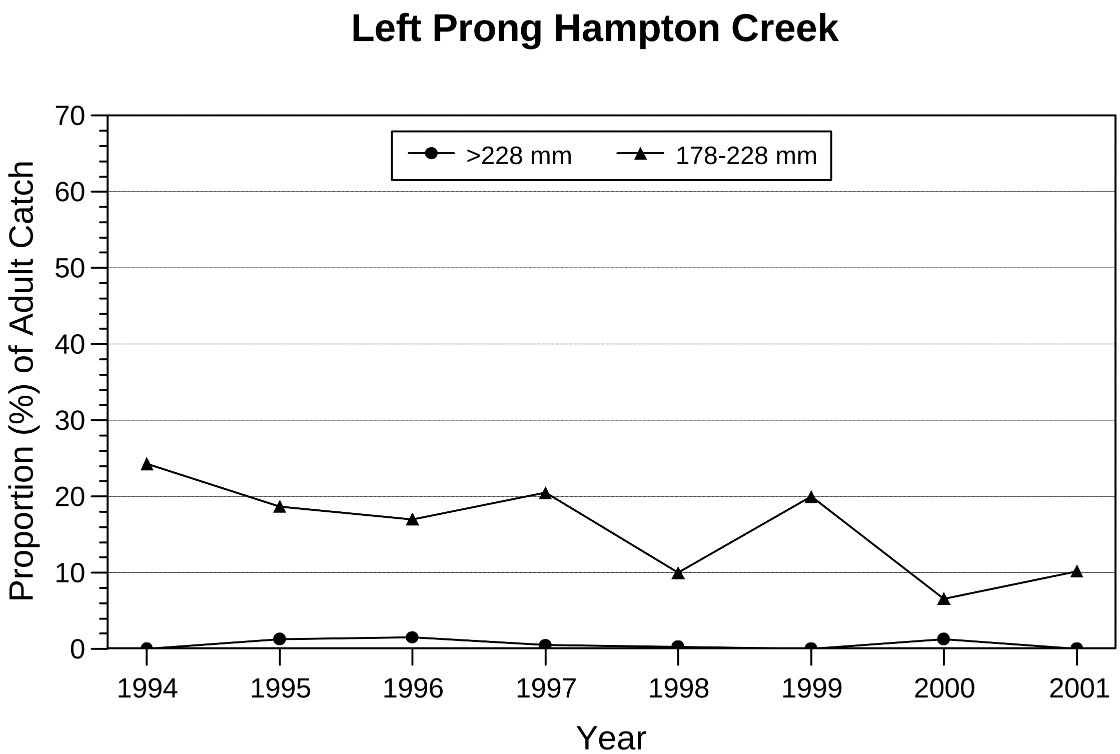


Figure 2-21. Relative abundances of larger rainbow trout at the Left Prong Hampton Creek long-term monitoring stations (1994-95 and 1999-01, Station 1; 1996-98, Stations 1-3 combined).

2.2.5 Right Prong Middle Branch

Study Area

Right Prong Middle Branch is a headwater tributary to the Doe and Watauga rivers. Its Roan Mountain watershed is forested and located largely within the CNF in Carter County. The stream contains an allopatric population of native, southern Appalachian brook trout upstream of State Route 143. Bivens (1979) surveyed the stream and provided the first documentation of its brook trout population. This site (Figure 2-22) was first sampled in 1994 (Strange and Habera 1995) and was added to the long-term monitoring program in 1997 because no high-elevation, native brook trout populations were previously represented. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-14.

Results and Discussion

Catch data and abundance estimates for brook trout sampled at the Right Prong Middle Branch station in 2001 are given in Table 2-15. Total density and standing crop estimates for 2001 decreased slightly relative to the 2000 estimates (Figure 2-23). All standing crop estimates since sampling resumed in 1997 have been below the initial estimate obtained in 1994 (65.79 kg/ha). Despite decreases caused by the flood in 1998 and (potentially) the dry conditions since 1999, average density and standing crop remain well above the statewide averages for brook trout (1,220 fish/ha and 21 kg/ha).

Good recruitment from the strong 1999 cohort again appeared evident in 2001 (Figure 2-24), as there was a notable increase in the number of fish in the 127- and 152 mm size classes over previous years (12 in 1999, 18 in 2000, and 27 in 2001). Several harvestable fish (152-mm size class and larger) were also present (Figure 2-24). Although no fish in the 229-mm size class or larger have been collected at the Right Prong Middle Branch site, this is typical for most brook trout populations.

Management Recommendations

No particular management of Right Prong Middle Branch is suggested at this time other than protection of the resource. Because of the small size of the stream and its relative obscurity, angling pressure is probably light; therefore, the current angling regulations are adequate. Sampling at the monitoring station should continue in order to increase our understanding of brook trout population dynamics.

Right Prong Middle Branch Monitoring Station

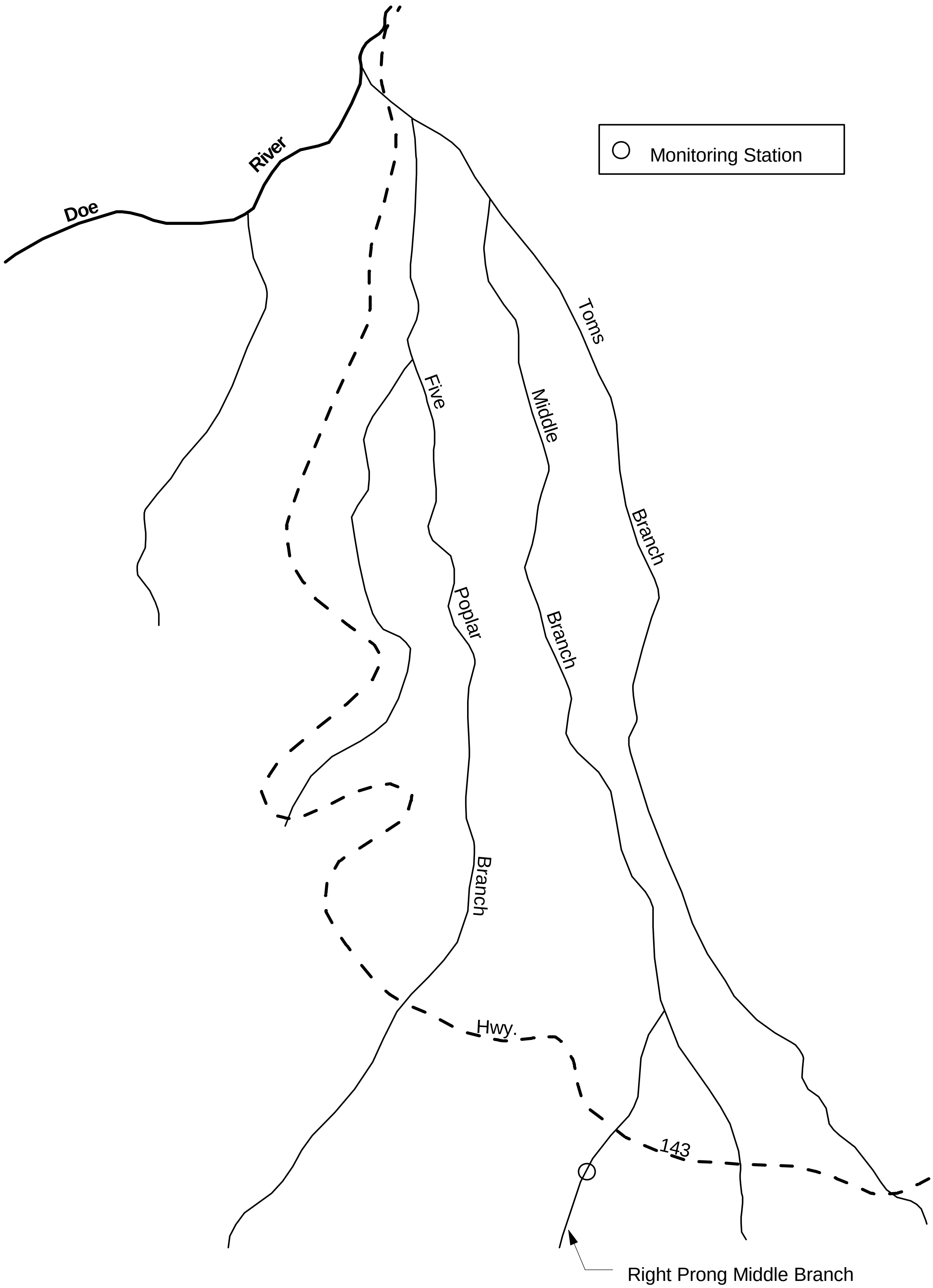


Figure 2-22. Location of the long-term monitoring station on Right Prong Middle Branch.

Table 2-14. Site and sampling information for Right Prong Middle Branch in 2001.

Location	Station 1
Site Code	420011401
Sample Date	17 August
Watershed	Watauga River
County	Carter
Quadrangle	Carvers Gap 208 SE
Lat-Long	360710N-820540W
Reach Number	06010103
Elevation (ft)	4,080
Stream Order	1
Land Ownership	USFS
Fishing Access	Limited
Description	This monitoring station begins at the head of a small island ~250 m upstream of the Rt. 143 crossing.

Effort	
Station Length (m)	90
Sample Area (m²)	333
Personnel	2
Electrofishing Units	1
Voltage (AC)	350
Removal Passes	3

Habitat	
Mean width (m)	3.7
Maximum depth (cm)	61
Canopy cover (%)	95
Aquatic vegetation	scarce
Estimated % of site in pools	33
Estimated % of site in riffles	67
Visual Hab. Assess. Score	154 (suboptimal)

Substrate Composition	Pool (%)	Riffle (%)
Silt	5	
Sand	15	5
Gravel	35	30
Rubble	15	30
Boulder	25	35
Bedrock	5	

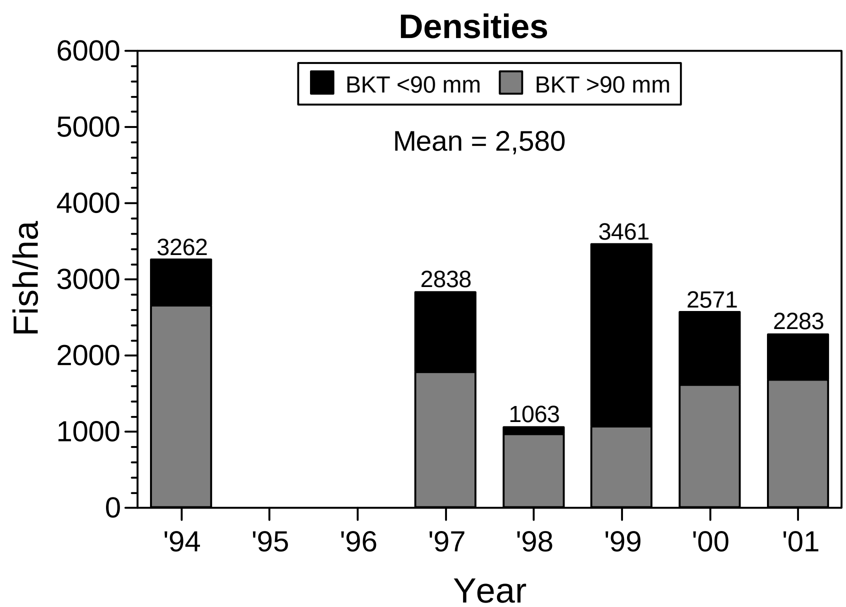
Water Quality	
Flow (cfs; visual)	normal
Temperature (C)	13.2
pH	6.8
Conductivity (uS/cm)	72
Dissolved Oxygen (mg/L)	--
Alkalinity (mg/L $CaCO_3$)	10

Table 2-15. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Right Prong Middle Branch sampled 17 August 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
BKT <90 mm	20	20	20	21	58	2.9	1.74	1.74	1.83	601	601	631
BKT >90 mm	54	56	54	61	1,384	24.7	41.56	40.05	45.25	1,682	1,622	1,832
Totals	**74**	**76**	**74**	**82**	**1,442**		**43.30**	**41.79**	**47.08**	**2,283**	**2,223**	**2,463**

Note: BKT = brook trout.

Right Prong Middle Branch



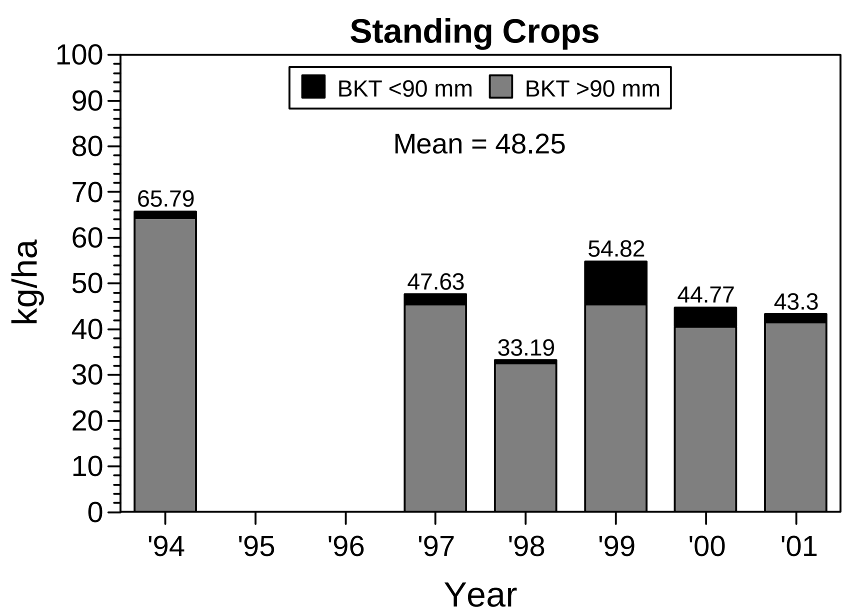


Figure 2-23. Annual (1994-2001) trout density and standing crop estimates for the monitoring station on Right Prong Middle Branch. BKT = brook trout. Bars indicate upper 95% confidence limits (overall).

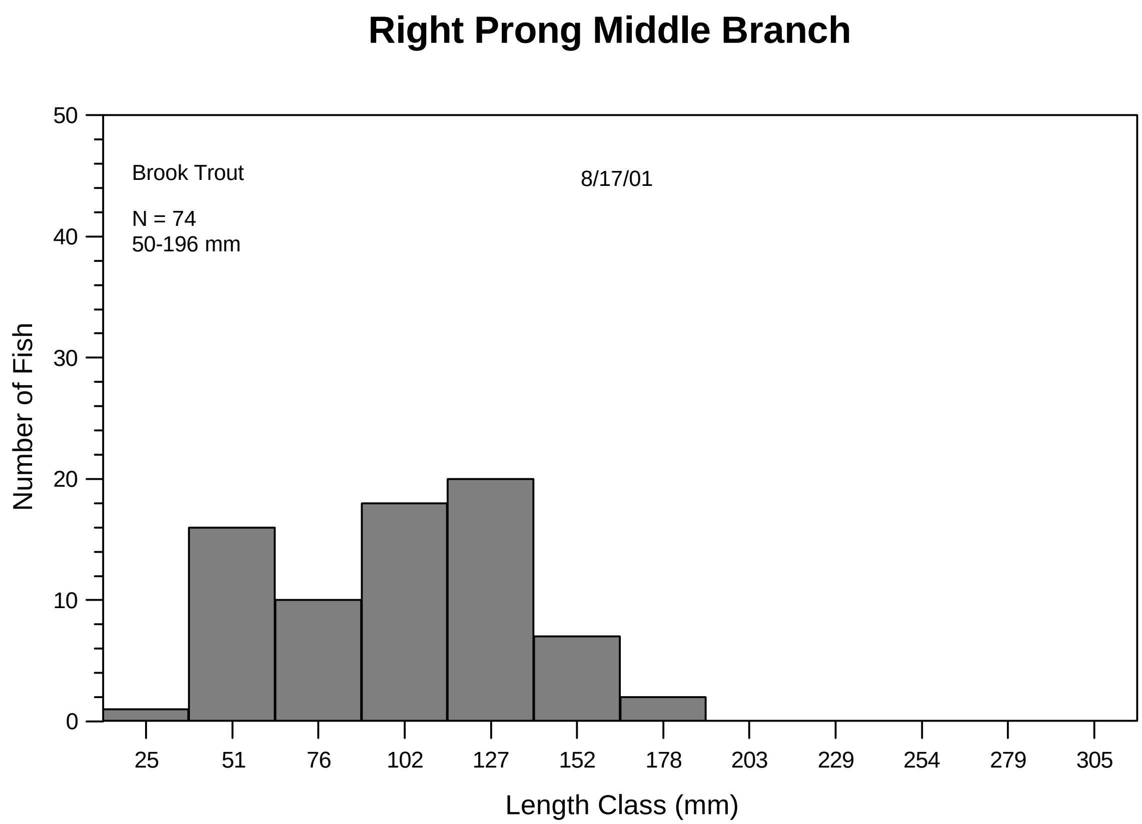


Figure 2-24. Length frequency distributions for brook trout from the 2001 Right Prong Middle Branch sample. Length classes shown (mm) correspond to inch groups (1-12).

2.2.6 Doe Creek

Study Area

Doe Creek is a spring-fed tributary to Watauga Reservoir that flows through privately owned land in Johnson County, much of which is being used for agricultural and residential purposes. It is probably best known for the trophy rainbow trout fishery it supported during the 1950s and 1960s. This fishery was provided by a fall-spawning stock of fish from Watauga Reservoir that probably originated from eggs planted at the mouth of Doe Creek in 1954 (Bivens et al. 1998). Despite attempts to improve declining spawning runs, the fishery disappeared in the early 1970s. However, Doe Creek still supports an outstanding population of wild rainbow trout. It has recently produced some of the highest abundance estimates and largest rainbow trout sampled in Tennessee streams. Doe Creek also receives some hatchery fish (March-July) and is subject to general trout fishing regulations. It was previously surveyed for TWRA by Shields (1950) and later qualitatively sampled by Bivens (1989). Ironically, Shields (1950) recommended that Doe Creek be removed from the trout stream list because of its limited trout carrying capacity and lack of potential for reproduction.

The current long-term monitoring station on Doe Creek (Figure 2-25) was established in 1993 and has been sampled annually since then. It is located along Highway 67 and ends just below the confluence with the outflow from Lowe Spring. Sample site location and effort details, along with habitat and water quality information are given in Table 2-16. Mountain City received a permit from TDEC in 2000 to withdraw 0.5 million gallons per day from Lowe Spring (during 7 p.m.-7 a.m.) to supplement its municipal water supply. During the 12-hour period when water is being withdrawn, the spring’s flow will be reduced by 1.55 CFS, which is an amount approaching 20% of the late summer average. Lowe Spring is an important source of cold water for Doe Creek (it provided 57% of the total stream flow during the 1998 sample). Qualitative surveys in October 2001(three 100-m sites) further document this spring’s importance. Few trout (and numerous sunfish) were found in Doe Creek beyond about 1.6 km (1 mi) upstream of the confluence with Lowe Spring. Therefore, TWRA remains concerned that removal of a substantial portion of the spring’s flow could impact Doe Creek’s wild rainbow trout population. Construction of withdrawal and treatment facilities began in 2001 and the system will likely become operational in 2002 (M. Braswell, TDEC, personal communication).

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Doe Creek station in 2001 are given in Table 2-17. The decline in rainbow trout standing crop that began in 1997 continued in 2001, resulting in the lowest estimate obtained to date (Figure 2-26). The rainbow trout standing crop present in 2001 (36.18 kg/ha) represents a 65% decrease from the 1997 level and is one of the largest declines in abundance observed recently among all long-term other monitoring stations. As with several other streams, the dry conditions present during the past few years appear to be responsible for impacting the quality of Doe Creek's wild rainbow trout population.

Non-salmonid abundance decreased substantially in 2001 (Figure 2-26), after generally increasing for several years (notwithstanding some imprecision associated with previous mottled sculpin samples). The abundance of cyprinids, particularly blacknose dace and stonerollers, remains substantially lower than the pre-flood (1993) level (Figure 2-26).

As in 2000, Doe Creek's rainbow trout population structure in 2001 was not as well balanced as it had been in previous years (Figure 2-27). The strong 1999 cohort did not appear to recruit well to age 2, as there was no change in the number of fish in the 178-mm and larger size groups. Rainbow trout in the 178-228 mm size range have typically made up 30-50% of all adults captured in Doe Creek, but the proportion remained below this range in 2001 (Figure 2-28). Fish ?229 mm have usually represented another 10-15% of the adult catch, but the 2001 sample was the first in which none of these larger fish were present (Figures 2-27 and 2-28).

Mean backcalculated lengths at age and mean capture lengths for rainbow trout during 1993-1997, based on scales (Strange and Habera 1998a), are given below. Total annual mortality (catch curve) was estimated to be 66% (Strange and Habera 1998a).

	Mean Length at Age (mm)					
	0	1	2	3	4	5
Rainbow (backcalculated)		118	184	223	271	308
Rainbow (at capture)	101	167	215	250		331

Age-0 rainbow trout collected at the monitoring station in 1998 were adipose clipped for future age validation purposes. Twelve of these clipped fish were recaptured in 1999 at age 1 (average length, 154 mm) and two were recaptured in 2000 at age 2 (average length, 181 mm), and two were recaptured in 2001 at age 3 (average length, 202 mm). Otoliths were removed from the fish recaptured in 2001 for age validation. Notwithstanding small sample sizes, mean lengths at capture of known age fish at all ages were lower (by 13-48 mm) than the corresponding means based on the 1993-1997 scale analyses. Perhaps scales are less accurate for ageing rainbows in Doe Creek than in other populations, or perhaps there has been an overall slowing of growth rate, in combination with the general abundance decline, since 1997. Additional rainbow trout otoliths will be collected and analyzed to validate scale-derived ages, and comparison of scale and otolith ages for individual fish should help clarify age and growth characteristics of this wild trout population.

Benthic macroinvertebrates collected at the Doe Creek site comprised 30 families representing 34 identified genera (Table 2-18). The most abundant organisms were mayflies, stoneflies, snails (gastropods), and true flies (dipterans), which together represented about 72% of the sample. Total taxa richness was 42 and EPT taxa richness was 21. Based on the EPT taxa richness value and the overall biotic index at this site, the relative health of the benthic community was classified as fair/good - good. Benthic taxa richness has been relatively stable since sampling began in 1993, while benthic organism abundance has been somewhat more variable (Figure 2-29).

Management Activities and Recommendations

Despite the current downward trend in trout abundance, Doe Creek remains one of Tennessee's most productive wild trout stream and TWRA is committed to protecting its quality. Because management of this extremely valuable fishery resource should feature the exceptional wild trout population, the current level of supplementation with hatchery fish should not be expanded. Annual sampling at the monitoring station should continue in order to continue evaluating impacts from the ongoing drought and to help identify any impacts related to water withdrawals from Lowe Spring. A creel survey on this stream would provide valuable information about angler use of the fishery and help guide future management decisions. The angling regulations currently in place are considered adequate to maintain the fishery.

In early March 2001, efforts to re-establish a population of rainbow trout that would live and grow in Watauga Lake and use Doe Creek to spawn were renewed. The Overmountain Chapter of Trout Unlimited (TU) in Johnson City funded the purchase of 25,000 eyed Kamloops rainbow trout eggs from a hatchery in the state of Washington. Kamloops rainbows are a lake-dwelling strain that ascends tributary streams to spawn. Members of the Overmountain TU Chapter and TWRA planted half of the eggs in the lower portion of Doe Creek. The remaining eggs were hatched at TWRA's Buffalo Springs facility and were stocked in lower Doe Creek in late May 2001 as fingerlings. This process will be repeated for the next two years if additional eggs can be acquired. Alternatively, other strains of rainbow trout with the appropriate characteristics may be tried, including eggs from the large fish that currently enter Clear Creek from the Clinch River (Norris tailwater) each winter. If successful, some of these rainbows may begin returning to spawn by 2004, adding a valuable dimension to Doe Creek's current wild trout fishery.

Doe Creek Monitoring Station

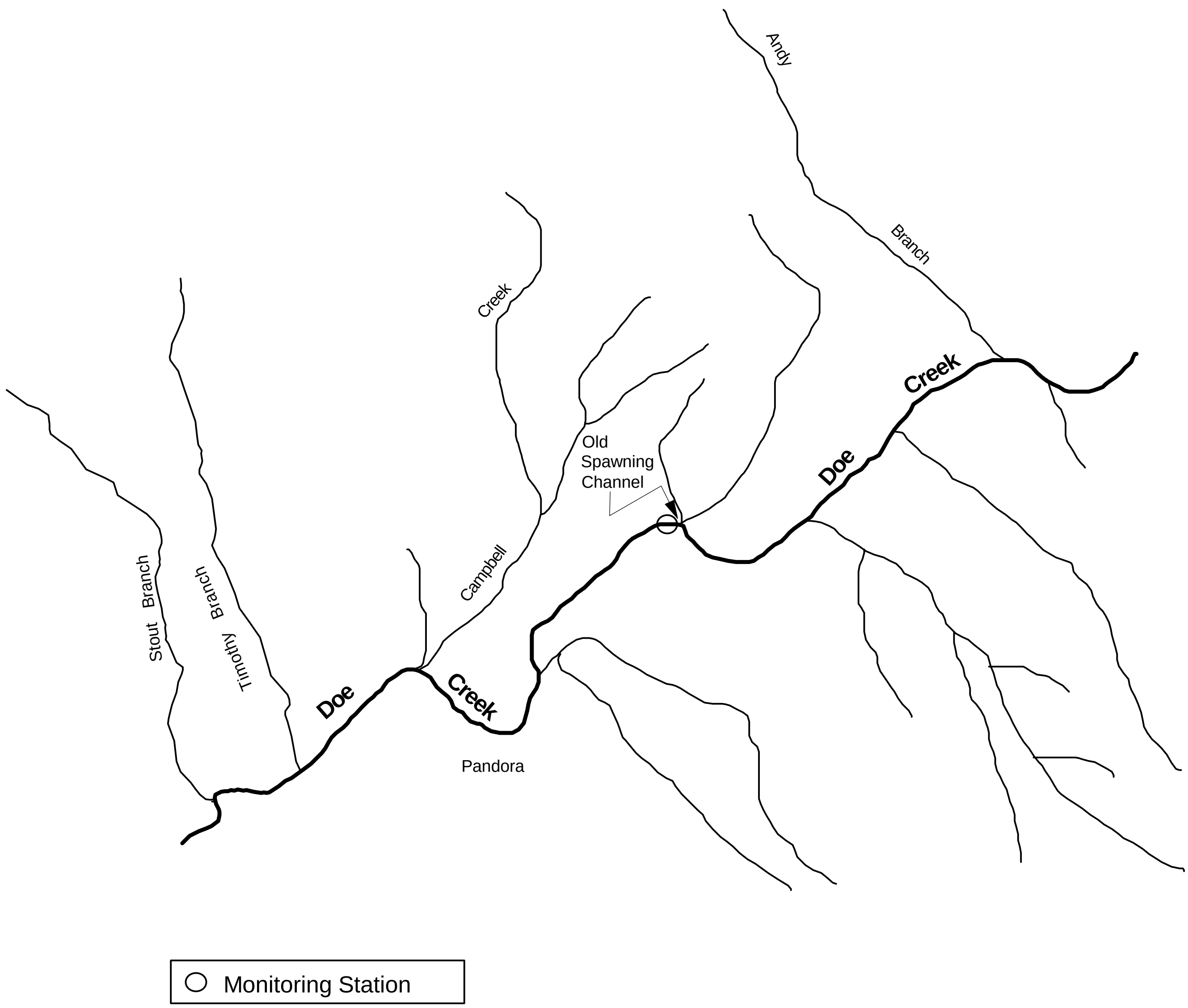


Figure 2-25. Location of the long-term monitoring station on Doe Creek.

Table 2-16. Site and sampling information for Doe Creek in 2001.

Location	Station 1
Site Code	420011601
Sample Date	05 September
Watershed	Watauga River
County	Johnson
Quadrangle	Doe 214 NW
Lat-Long	362537N-815614W
Reach Number	06010103-37,0
Elevation (ft)	2,210
Stream Order	4
Land Ownership	Private
Fishing Access	Good
Description	Site ends at small dam just below Lowe spring.

Effort	
Station Length (m)	134
Sample Area (m²)	992
Personnel	13
Electrofishing Units	3
Voltage (AC)	125-150
Removal Passes	3

Habitat	
Mean width (m)	7.4
Maximum depth (cm)	80
Canopy cover (%)	40
Aquatic vegetation	common
Estimated % of site in pools	29
Estimated % of site in riffles	71
Visual Hab. Assess. Score	155 (suboptimal)

Substrate Composition	Pool (%)	Riffle (%)
Silt	5	
Sand	15	15
Gravel	25	25
Rubble	20	35
Boulder	15	20
Bedrock	20	5

Water Quality	
Flow (cfs; visual)	29.3; somewhat high
Temperature (C)	16.8
pH	7.6
Conductivity (uS/cm)	159
Dissolved Oxygen (mg/L)	9.4
Alkalinity (mg/L $CaCO_3$)	75

Table 2-17. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Doe Creek sampled 5 September 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
RBT <90 mm	71	98	71	135	642	6.5	6.47	4.65	8.85	988	716	1,361
RBT >90 mm	89	90	89	93	2,947	32.7	29.71	29.34	30.66	907	897	938
Mottled sculpin	308	477	361	593	1,426	3.0	14.38	10.92	17.93	4,808	3,639	5,978
Stoneroller	92	99	92	108	1,976	20.0	19.92	18.55	21.77	998	927	1,089
Blacknose dace	110	129	110	149	446	3.5	4.50	3.88	5.26	1,300	1,109	1,502
N. hogsucker	2	2	2	7	298	149.0	3.00	3.00	10.51	20	20	71
Fantail darter	16	25	16	55	53	2.1	0.53	0.34	1.16	252	161	554
Totals	**688**	**920**	**741**	**1,140**	**7,788**		**78.51**	**70.68**	**96.14**	**9,273**	**7,469**	**11,493**

Note: RBT = rainbow trout.

Doe Creek

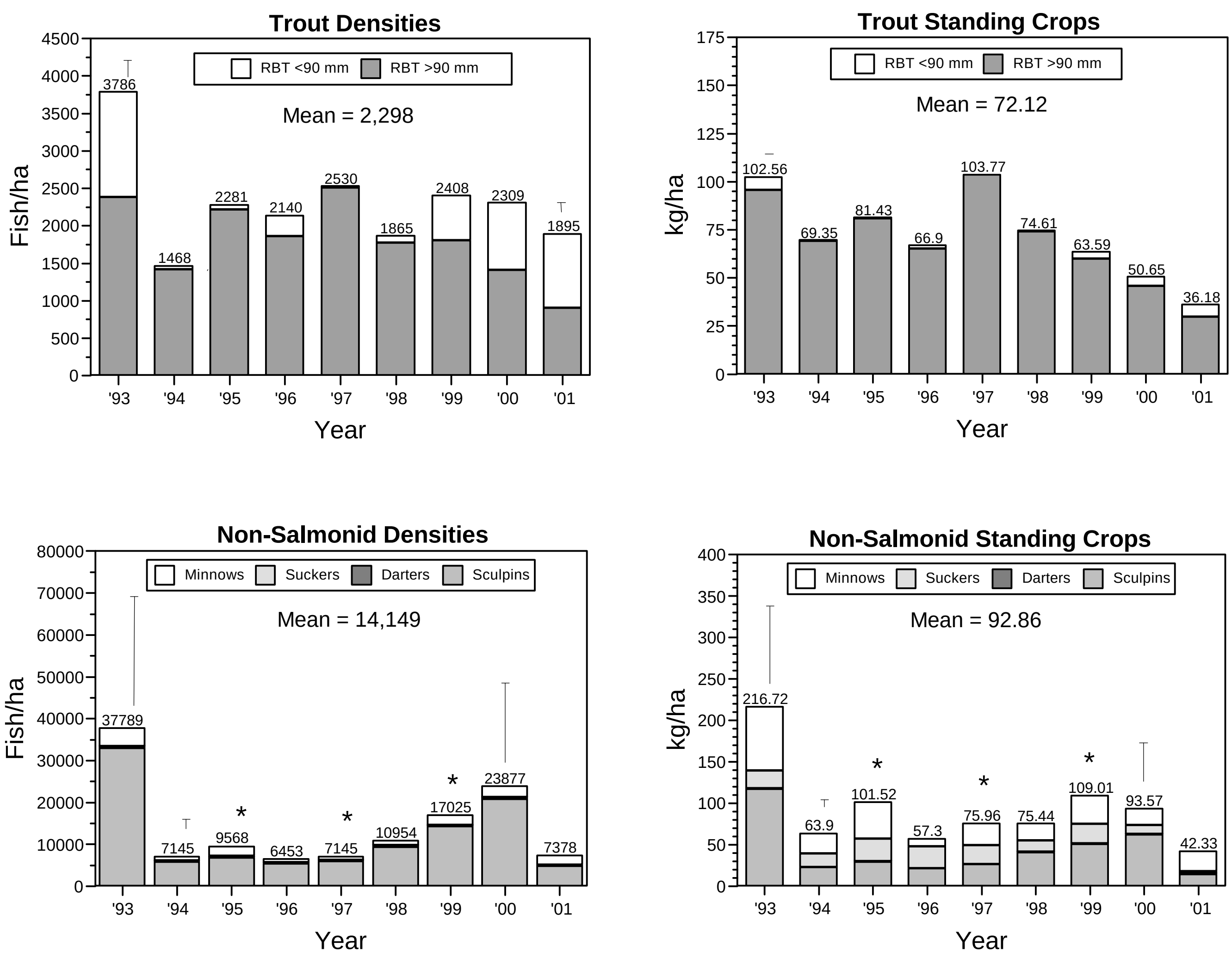


Figure 2-26. Annual (1993-2001) trout and non-salmonid density and standing crop estimates for the monitoring station on Doe Creek. RBT = rainbow trout. Bars indicate upper 95% confidence limits (overall). Samples that included species with a non-descending removal pattern are designated by an asterisk (*).

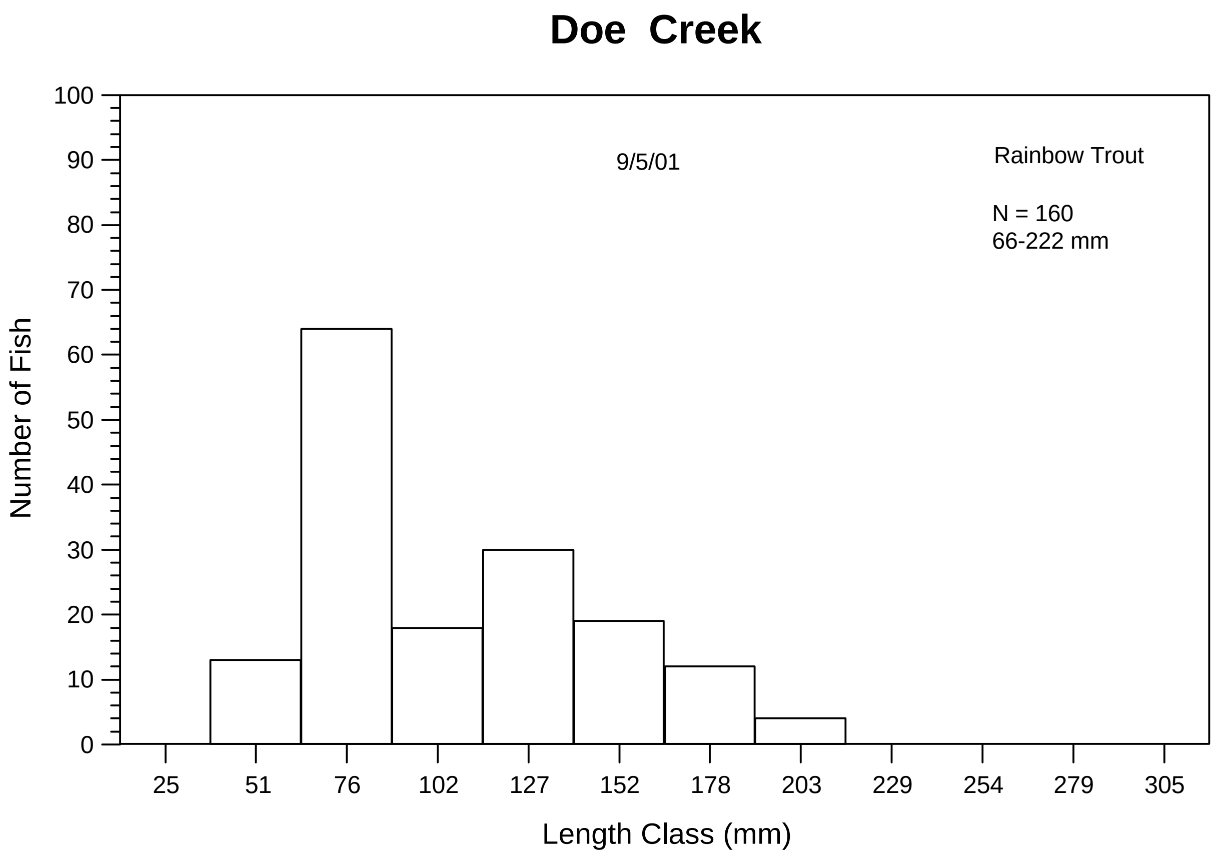


Figure 2-27. Length frequency distributions for rainbow trout from the 2001 Doe Creek sample. Length classes shown (mm) correspond to inch groups (1-12).

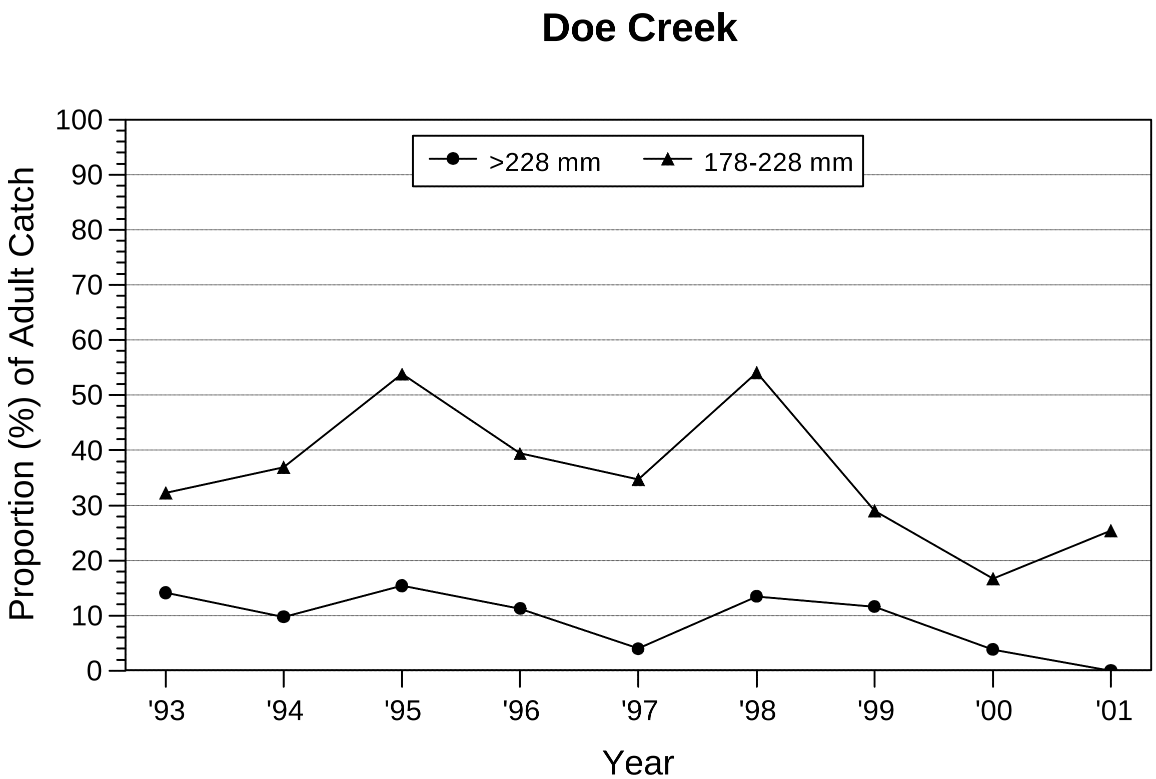


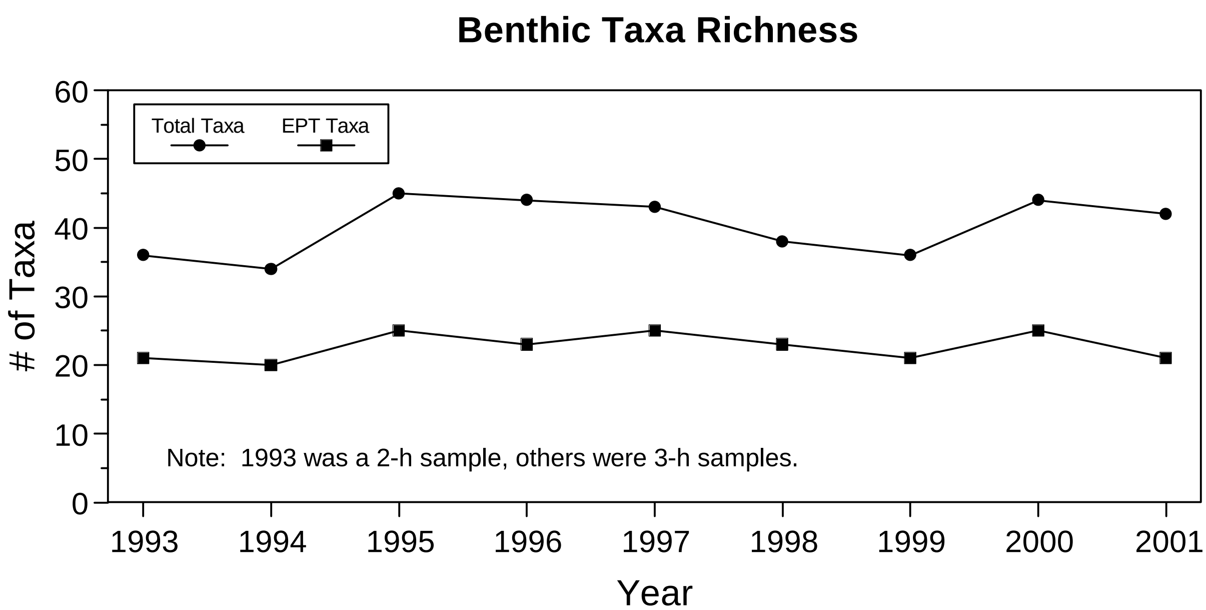
Figure 2-28. Relative abundances of larger rainbow trout at the Doe Creek long-term monitoring station.

Table 2-18. Benthic organisms sampled at Doe Creek in 2001 (Field # RDB-2001-27). Total sampling effort was 3 h.

Order	Family	*Genus / species*	Number	Percent
ANNELIDA				0.3
	Oligochaeta		1	
COLEOPTERA				12.0
	Elmidae	*Dubiraphia* adults	2	
		Macronychus glabratus larva	1	
		Optioservus larvae	6	
		Optioservus ovalis adults	11	
		Stenelmis adult	1	
	Psephenidae	*Psephenus herricki*	17	
DECAPODA				0.3
	Cambaridae	*Cambarus longirostris*	1	
DIPTERA				12.9
	Blephariceridae	*Blepharicera*	4	
	Chironomidae		8	
	Simuliidae		27	
	Tipulidae	*Tipula*	2	
EPHEMEROPTERA				23.0
	Baetidae	*Baetis*	43	
	Baetidae (non *Baetis*)		1	
	Ephemerellidae	*Ephemerella*	2	
		Serratella	5	
	Ephemeridae	*Ephemera*	1	
	Heptageniidae	*Epeorus rubidus/subpallidus*	3	
		Stenacron (probably *carolina)*	1	
		Stenacron (probably *interpunctatum)*	9	
		Stenonema early instars	4	
	Isonychiidae	*Isonychia*	2	
	Leptophlebiidae	*Paraleptophlebia*	2	
GASTROPODA				17.4
	Physidae		2	
	Pleuroceridae	*Elimia*	53	
ISOPODA				0.6
	Asellidae	*Asellus*	2	
MEGALOPTERA				2.5
	Corydalidae	*Nigronia serricornis*	7	
	Sialidae	*Sialis*	1	
NEMATOMORPHA			1	0.3
ODONATA				2.5
	Aeshnidae	*Boyeria vinosa*	4	
	Gomphidae	*Gomphus* early instar	2	
		Hagenius brevistylus	1	
		Lanthus vernalis	1	
PLECOPTERA				18.3
	Leuctridae	*Leuctra*	28	
	Perlidae	*Acroneuria abnormis*	1	
	Pteronarcyidae	*Pteronarcys (Allonarcys)*	29	
TRICHOPTERA				9.8
	Brachycentridae	*Micrasema charonis/scotti*	5	
	Hydropsychidae	*Cheumatopsyche*	14	
	Limnephilidae	*Pycnopsyche* pupae	5	
	Philopotamidae	*Dolophilodes distinctus* pupa	1	
	Rhyacophilidae	*Rhyacophila fuscula*	3	
		Rhyacophila pupa *(carolina* group*)*	1	
	Uenoidae	*Neophylax* pupae	2	
TOTAL			**317**	100.0

Taxa richness = 42; EPT taxa richness = 21; bioclassification = 3.7 (Fair/Good - Good).

Doe Creek



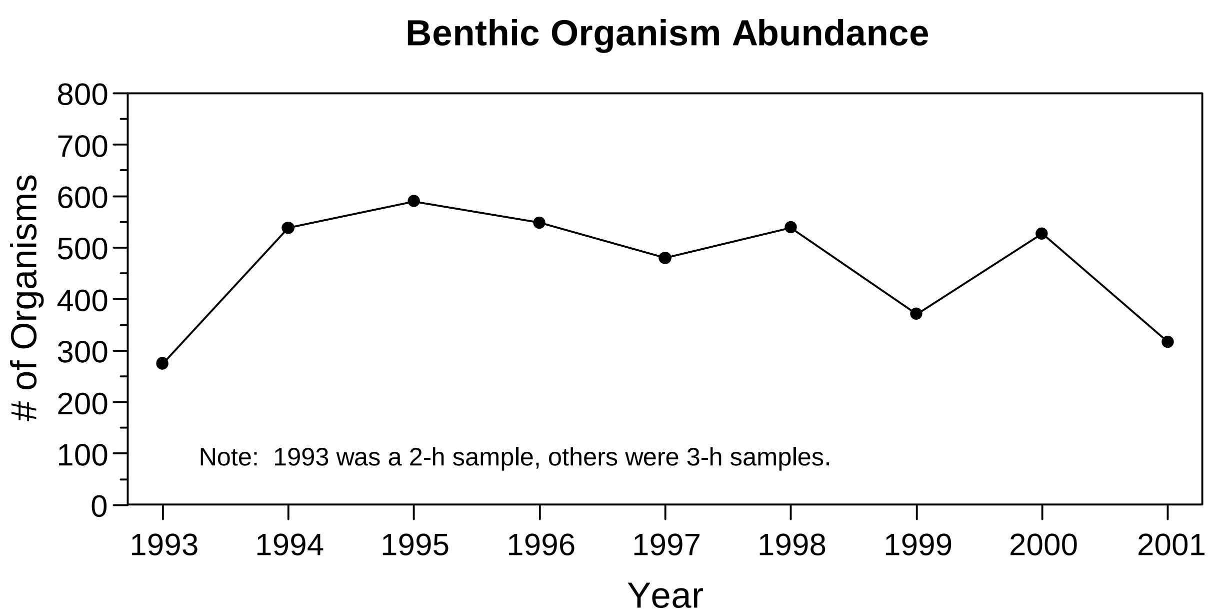


Figure 2-29. Benthic taxa richness and abundance for Doe Creek during 1993-2001.

2.2.7 Beaverdam Creek

Study Area

Beaverdam Creek is one of Tennessee's larger and better-known wild trout streams. The watershed is largely forested (much is CNF), although there is substantial agricultural and residential land use in the Shady Valley area. This stream now supports excellent populations of wild rainbow and brown trout. Eleven tributaries contain brook trout, most of which are of native, southern Appalachian heritage (Strange and Habera 1997). Management of this stream as a put-and-take fishery was changed in 1988 to emphasize wild trout. A three-fish creel limit was added to the 229-mm minimum size limit and single-hook, artificial-lures-only regulations already in place on a portion of the stream and stocking was discontinued within this area.

Previously, Shields (1950), Bivens (1988), and Bivens and Williams (1990) conducted qualitative surveys for TWRA. Two long-term monitoring stations (Figure 2-30) were established in 1991 on the portion of Beaverdam Creek within the CNF and have been sampled annually since then. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-19.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Beaverdam Creek stations in 2001 are given in Table 2-20. Total trout density decreased at both stations again in 2001(Figure 2-31). Reductions in the number of adult brown trout were primarily responsible. Total brown trout density at both stations since 1999 has remained substantially higher than in any year during 1991-1998. Total trout standing crop at Station 1 has been quite stable over the 11 years since sampling began, even since 1997 when other monitoring sites have undergone declines (Figure 2-31). Total trout standing crop at Station 2 decreased again somewhat in 2001 after a steady increase from 1991 through 1999 (Figure 2-31). Accompanying the increase in standing crop at Station 2 has been a gradual increase in the relative proportion of brown trout biomass (Figure 2-31). Since 1999, total trout standing crop has been primarily composed of brown trout. Although increasing average size of brown trout at this site appears to be involved, abundance has also increased recently.

Beaverdam Creek has one of the more diverse fish communities among Tennessee's wild trout streams and its non-salmonid (nongame and forage fish) abundance estimates have consistently been among the highest measured each year. Both estimates of abundance have oscillated from year to year since 1991 (Figure 2-32). Minnows (particularly river chubs, stonerollers, and saffron shiners) and sculpins appeared to cause most of the variability, although reduced precision associated with sampling certain species (e.g., sculpins and darters) has been a factor in some years. It is not known what effect annual three-pass depletion sampling (electrofishing, handling, etc.) has on these species, but no negative trend is apparent.

Relatively strong 2001 cohorts of rainbow and brown trout were present at both stations, and populations of both species were generally well balanced in 2001 except for the absence of larger browns (Figure 2-33). Brown trout in the 330-mm size class and larger have usually been captured in previous samples, particularly at Station 1, but none were collected or observed in 2001. Trout in the 178-mm size class and larger would be most interesting to anglers, and rainbows in the 178-228 mm (7-9 in.) size range have represented 20-50% of all adults sampled in Beaverdam Creek except in 2000 (Figure 2-34). Larger rainbows (?229 mm) have typically made up another 10-20% of the adult catch, and the proportion in 2001 remained within this range (Figure 2-34). Brown trout exhibited more annual variability, as fish in the 178- to 228-mm class fluctuated between 0% and 60% and fish ?229 mm made up 20-100% (Figure 2-34). Small sample sizes in some years, faster growth by brown trout, and year-class failures are all factors that influence variability, particularly in comparison with rainbow trout. However, in each year except 1994 and 2000, at least two thirds of all adult brown trout were ?178 mm.

Mean backcalculated lengths at age and mean capture lengths for rainbow and brown trout during 1991-1997, based on scales (Strange and Habera 1998a), are given below. Total annual mortality (catch curve) was estimated to be 64% for rainbow trout and 50% for brown trout (Strange and Habera 1998a).

	Mean Length at Age (mm)							
	0	1	2	3	4	5	6	7
Rainbow (backcalculated)		99	173	225	273			
Rainbow (at capture)	74	160	220	254	300			
Brown (backcalculated)		98	202	294	358	455	536	528
Brown (at capture)	89	181	258	323	361	472	585	550

Age-0 brown and rainbow trout were adipose clipped at both stations in 1997 for future age validation purposes. Twenty-eight rainbows and seven browns were recaptured in 1998 at age 1, six rainbows and one brown were recaptured in 1999 at age 2, two rainbows were recaptured in 2000 at age 3, and one rainbow was recaptured in 2001 at age 4. Average lengths at ages 1-4 were 164, 204, 261, and 249 mm for recaptured rainbows. Recaptured brown trout averaged 174 mm at age 1 and 257 mm at age 2. No marked brown trout have been recaptured since 1999 and none of those adipose clipped in 1992 (age 9) were collected. Overall, mean lengths at capture for known-age (clipped) rainbow and brown trout were comparable to those determined by scale analyses (1991-1997). Additionally, the rarity of marked age-3 and older rainbows in the 2000 samples also confirms the lack of older fish identified using scales and the relatively high estimated annual mortality rate. Analyses of otoliths from other brown trout collected in Beaverdam Creek (1996) documented the presence of fish up to age 10 and the inaccuracy of scales for ageing specimens beyond age 4.

Management Activities and Recommendations

By all measures, Beaverdam Creek is one of Tennessee's finest wild trout fisheries and management as such should continue. In particular, there should be no expansion of the area or number of hatchery fish currently stocked. Annual monitoring should continue in order to increase our understanding of wild trout populations. A creel survey on this stream would provide valuable information about angler use of the fishery and help guide future management decisions. The current fishing regulations are adequate, although there is no indication that the 229-mm minimum size limit and 3-fish creel limit are biologically significant (Strange and Habera 1995). To address the lack of trout in the Shady Valley portion of Beaverdam Creek identified in 2000 (Habera et al. 2001a), ~5,000 brown trout fingerlings were stocked in early July 2001. This portion of Beaverdam Creek has been channelized and seems to lack spawning habitat, but might still be capable of carrying enough adult trout to support a fishery. The fingerlings were released in the general vicinity of the Highway 421 bridge and additional stockings should be made and evaluated during the next few years if fish are available.

Beaverdam Creek Monitoring Stations

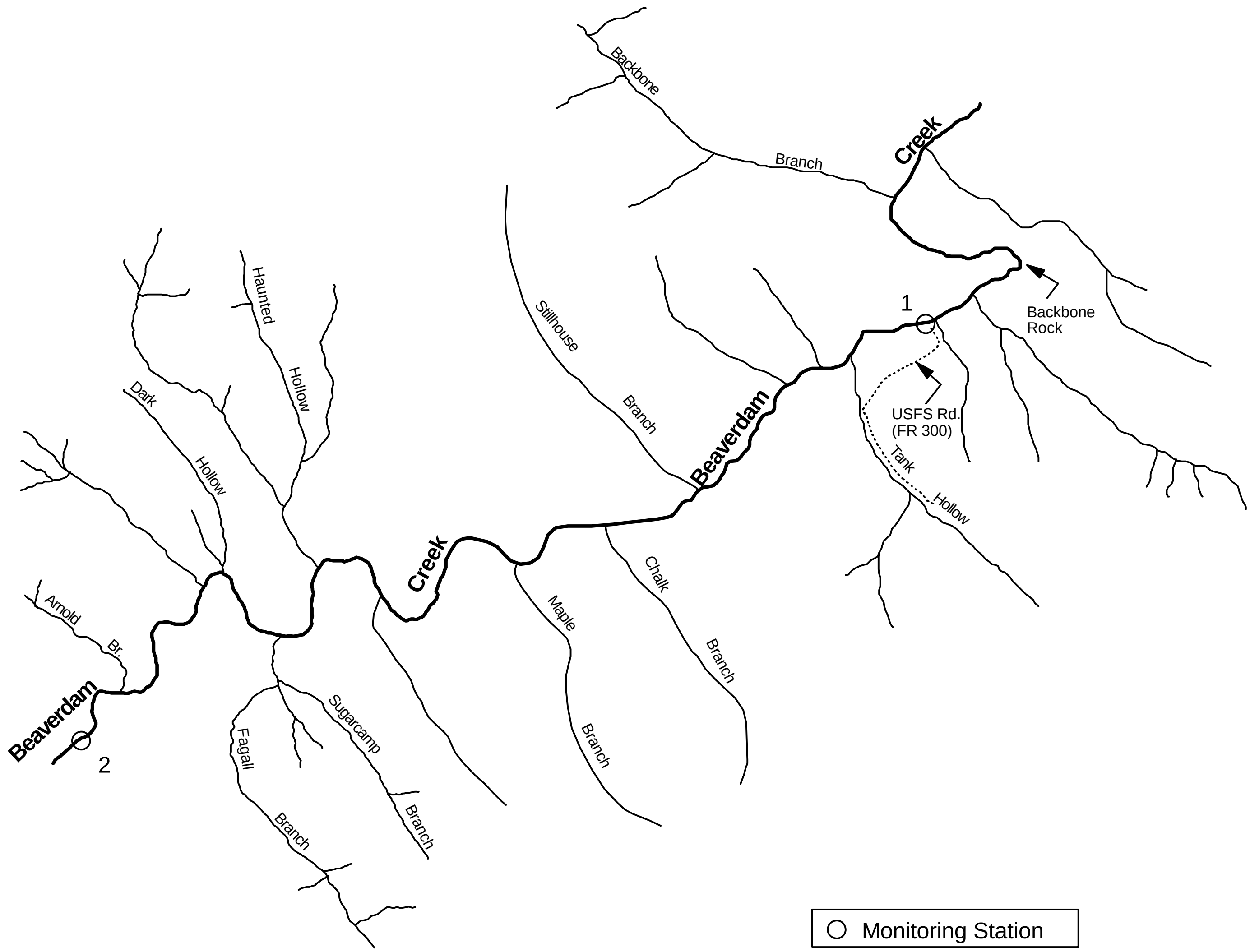


Figure 2-30. Locations of the two long-term monitoring stations on Beaverdam Creek.

Table 2-19. Site and sampling information for Beaverdam Creek in 2001.

Location	**Station 1**		**Station 2**	
Site Code	420011801		420011802	
Sample Date	18 September		19 September	
Watershed	S. Fork Holston River		S. Fork Holston River	
County	Johnson		Johnson	
Quadrangle	Laurel Bloomery 213 SE		Laurel Bloomery 213 SE	
Lat-Long	363532N-814903W		363358N-815218W	
Reach Number	06010102-23,0		06010102-23,0	
Elevation (ft)	2,160		2,440	
Stream Order	4		4	
Land Ownership	USFS		USFS	
Fishing Access	Excellent		Excellent	
Description	Begins at Tank Hollow Rd. near Backbone Rock.		Begins at Hwy. 133 mile marker 5 near Arnold Br.	
Effort				
Station Length (m)	200		177	
Sample Area (m²)	2,200		2,354	
Personnel	21		20	
Electrofishing Units	4		4	
Voltage (AC)	250		250	
Removal Passes	3		3	
Habitat				
Mean width (m)	11.0		13.3	
Maximum depth (cm)	120		142	
Canopy cover (%)	70		60	
Aquatic vegetation	scarce		scarce	
Estimated % of site in pools	46		43	
Estimated % of site in riffles	54		57	
Visual Hab. Assess. Score	165 (optimal)		162 (optimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**	**Pool (%)**	**Riffle (%)**
Silt	5		5	
Sand	5	5	10	5
Gravel	15	25	20	25
Rubble	40	35	25	35
Boulder	15	30	30	30
Bedrock	20	5	10	5
Water Quality				
Flow (cfs; visual)	23.5; normal		14.8; normal	
Temperature (C)	14.7		12.9	
pH	7.3		7.3	
Conductivity (uS/cm)	78		91	
Dissolved Oxygen (mg/L)	9.5		9.4	
Alkalinity (mg/L $CaCO_3$)	35		40	

Table 2-20. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for two stations on Beaverdam Creek sampled 18-19 September 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
Station 1												
RBT <90 mm	45	45	45	47	179	4.0	0.81	0.81	0.85	205	205	214
RBT >90 mm	57	57	57	59	3,875	68.0	17.61	17.61	18.24	259	259	268
BNT <90 mm	58	66	58	78	356	5.4	1.62	1.42	1.91	300	264	355
BNT >90 mm	40	40	40	41	3,625	90.6	16.48	16.48	16.88	182	182	186
Longnose dace	18	20	18	27	211	10.6	0.96	0.87	1.30	91	82	123
Tennessee dace	1	1	1	1	4	4.0	0.02	0.02	0.02	5	5	5
Mottled sculpin	727	1,626	1,076	2,176	6,878	4.2	31.26	20.54	41.54	7,391	4,891	9,891
Warpaint shiner	49	49	49	51	279	5.7	1.27	1.27	1.32	223	223	232
Saffron shiner	218	224	218	231	544	2.4	2.47	2.38	2.52	1,018	991	1,050
Tennessee shiner	2	2	2	2	10	5.0	0.05	0.05	0.05	9	9	9
River chub	380	411	392	430	3,964	9.6	18.02	17.11	18.76	1,868	1,782	1,955
C. stoneroller	182	195	183	207	4,736	24.3	21.53	20.21	22.86	886	832	941
Fantail darter	84	103	84	126	147	1.4	0.67	0.53	0.80	468	382	573
Greenfin darter	35	68	35	152	519	7.6	2.36	1.21	5.25	309	159	691
Snubnose darter	44	50	44	61	98	2.0	0.45	0.40	0.55	227	200	277
Swannanoa darter	5	5	5	5	35	7.0	0.16	0.16	0.16	23	23	23
N. hogsucker	28	28	28	29	4,925	175.9	22.39	22.39	23.19	127	127	132
White sucker	2	2	2	15	6	3.0	0.03	0.03	0.20	9	9	68
Totals	**1,975**	**2,992**	**2,337**	**3,738**	**30,391**		**138.16**	**123.49**	**156.40**	**13,600**	**10,625**	**16,993**
Station 2												
RBT <90 mm	60	65	60	73	284	4.4	1.21	1.12	1.36	276	255	310
RBT >90 mm	66	66	66	67	3,220	48.8	13.68	13.68	13.89	280	280	285
BKT <90 mm	1	1	1	1	3	3.0	0.01	0.01	0.01	4	4	4
BNT <90 mm	32	32	32	34	184	5.8	0.78	0.78	0.84	136	136	144
BNT >90 mm	62	62	62	64	3,928	63.4	16.69	16.69	17.24	263	263	272
Longnose dace	11	11	11	14	120	10.9	0.51	0.51	0.65	47	47	59
Blacknose dace	6	6	6	7	12	2.0	0.05	0.05	0.06	25	25	30
Mottled sculpin	620	1,002	812	1,192	4,053	4.0	17.22	13.80	20.25	4,257	3,449	5,064
Warpaint shiner	16	17	16	22	114	6.7	0.48	0.46	0.63	72	68	93
Saffron shiner	80	84	80	90	224	2.7	0.95	0.92	1.03	357	340	382
Creek chub	1	1	1	1	25	25.0	0.11	0.11	0.11	4	4	4
River chub	230	237	230	244	3,613	15.2	15.35	14.85	15.76	1,007	977	1,037
C. stoneroller	47	52	47	61	595	11.4	2.53	2.28	2.95	221	200	259
Fantail darter	47	59	47	79	98	1.7	0.42	0.34	0.57	251	200	336
Greenfin darter	28	64	28	183	434	6.8	1.84	0.81	5.29	272	119	777
Snubnose darter	24	25	24	29	46	1.8	0.20	0.18	0.22	106	102	123
Swannanoa darter	16	17	16	22	77	4.5	0.33	0.31	0.42	72	68	93
N. hogsucker	5	5	5	6	259	51.8	1.10	1.10	1.32	21	21	25
White sucker	2	2	2	2	435	217.5	1.85	1.85	1.85	8	8	8
Rock bass	2	2	2	2	43	21.5	0.18	0.18	0.18	8	8	8
Totals	**1,356**	**1,810**	**1,548**	**2,193**	**17,767**		**75.49**	**70.03**	**84.63**	**7,687**	**6,574**	**9,313**

Note: RBT = rainbow trout, BKT = brook trout, and BNT = brown trout.

Beaverdam Creek

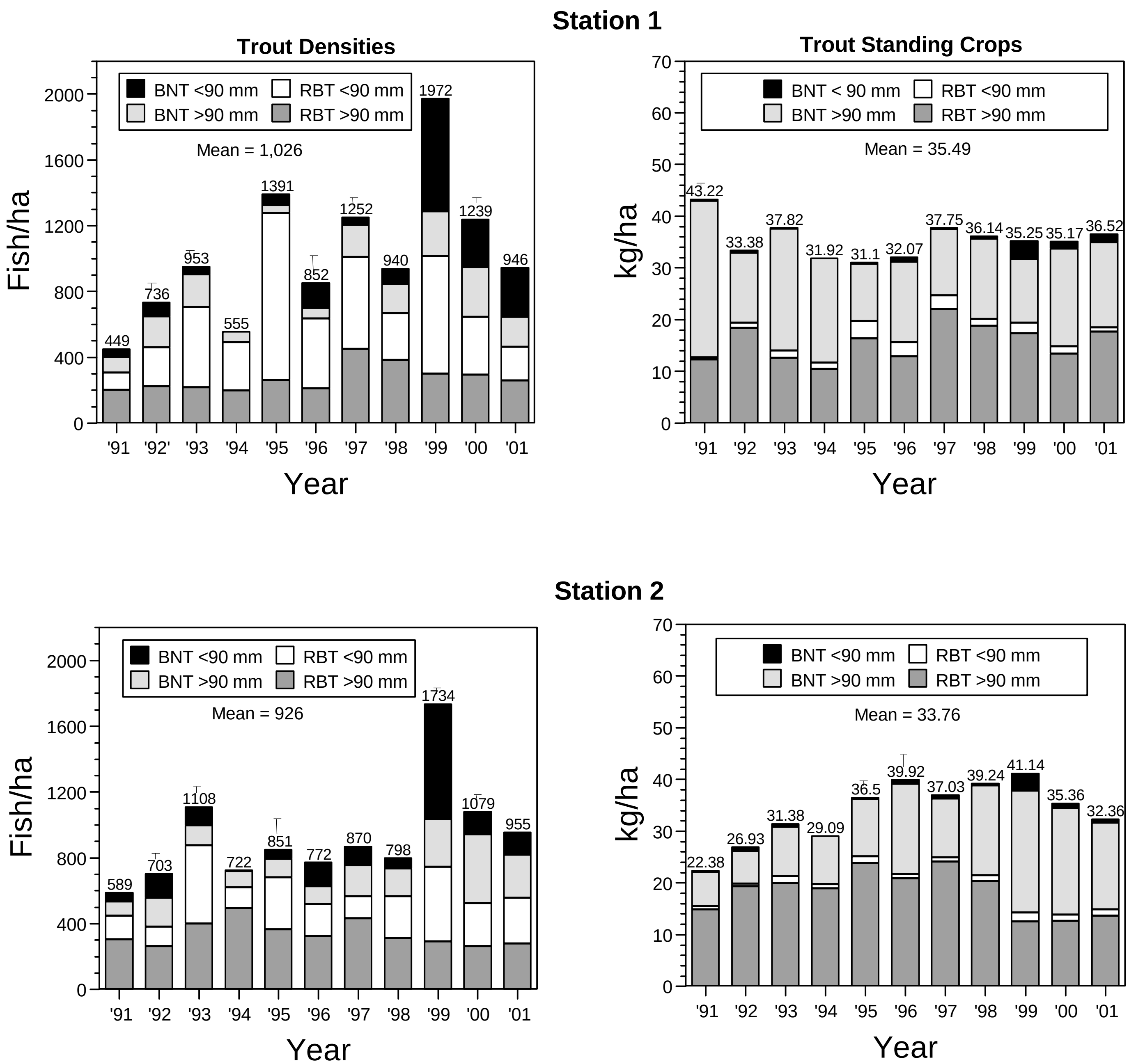
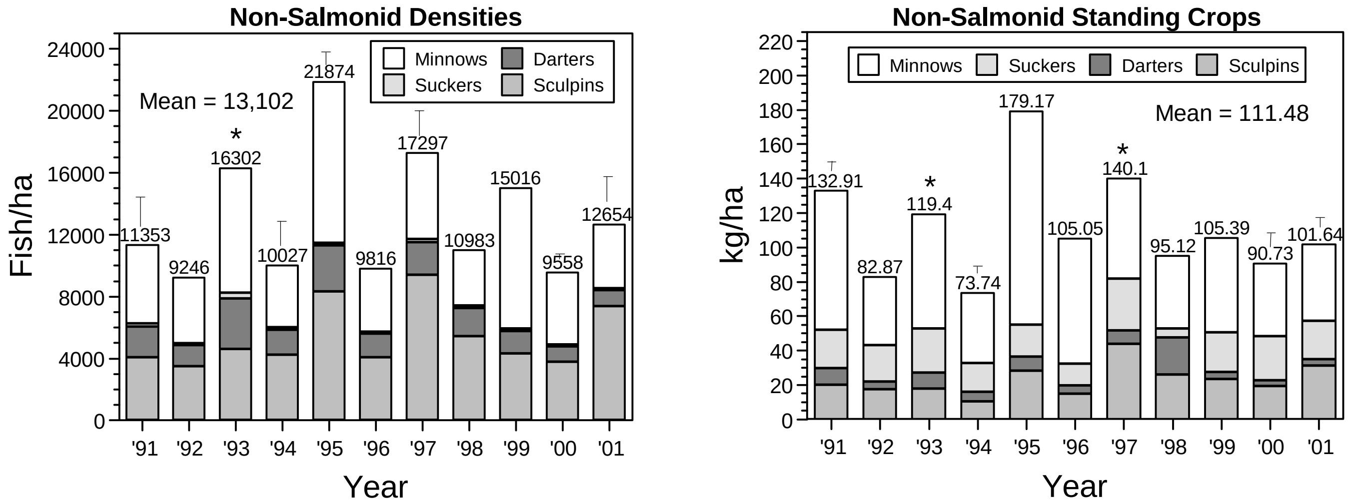


Figure 2-31. Annual (1991-2001) trout density and standing crop estimates for the two monitoring stations on Beaverdam Creek. RBT = rainbow and BNT = brown trout. Bars indicate upper 95% confidence limits (overall).

Beaverdam Creek

Station 1



Station 2

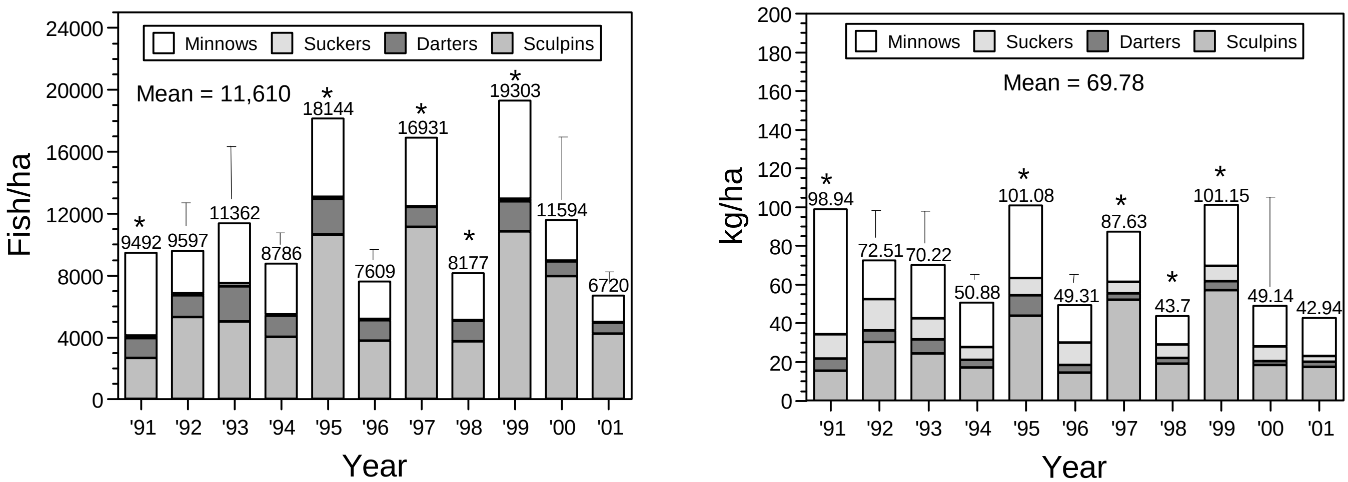
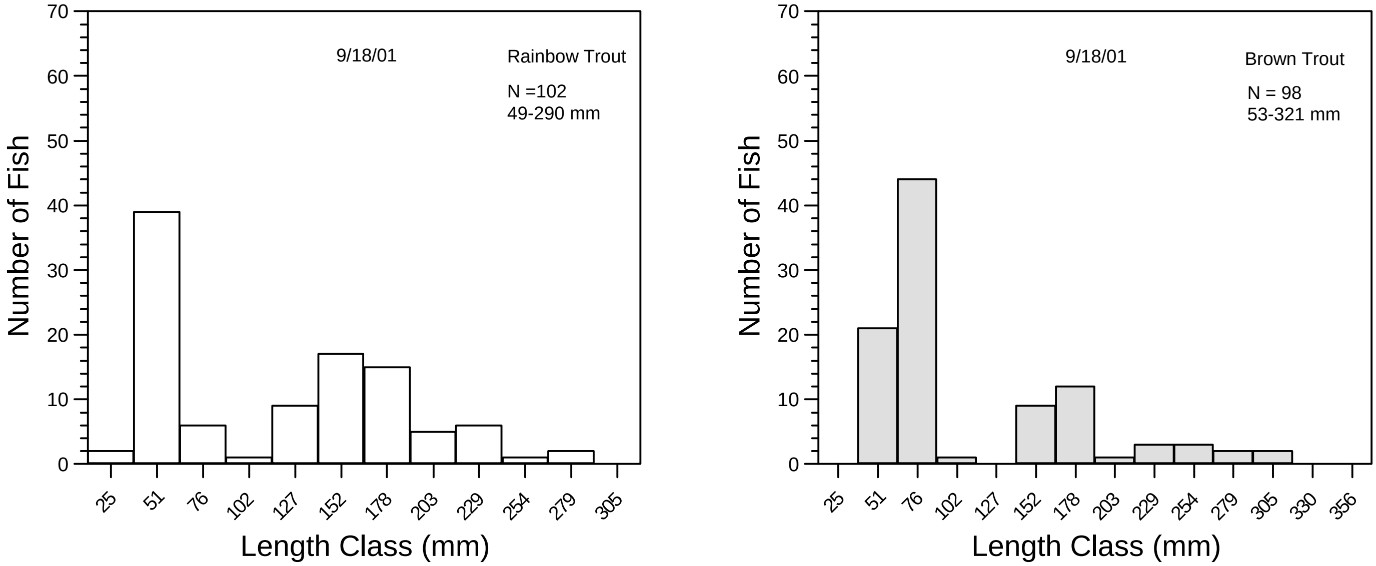


Figure 2-32. Annual (1991-2001) non-salmonid density and standing crop estimates for the two monitoring stations on Beaverdam Creek. Bars indicate upper 95% confidence limits (overall). Samples that included species with a non-descending removal pattern are designated by an asterisk (*).

Beaverdam Creek

Station 1



Station 2

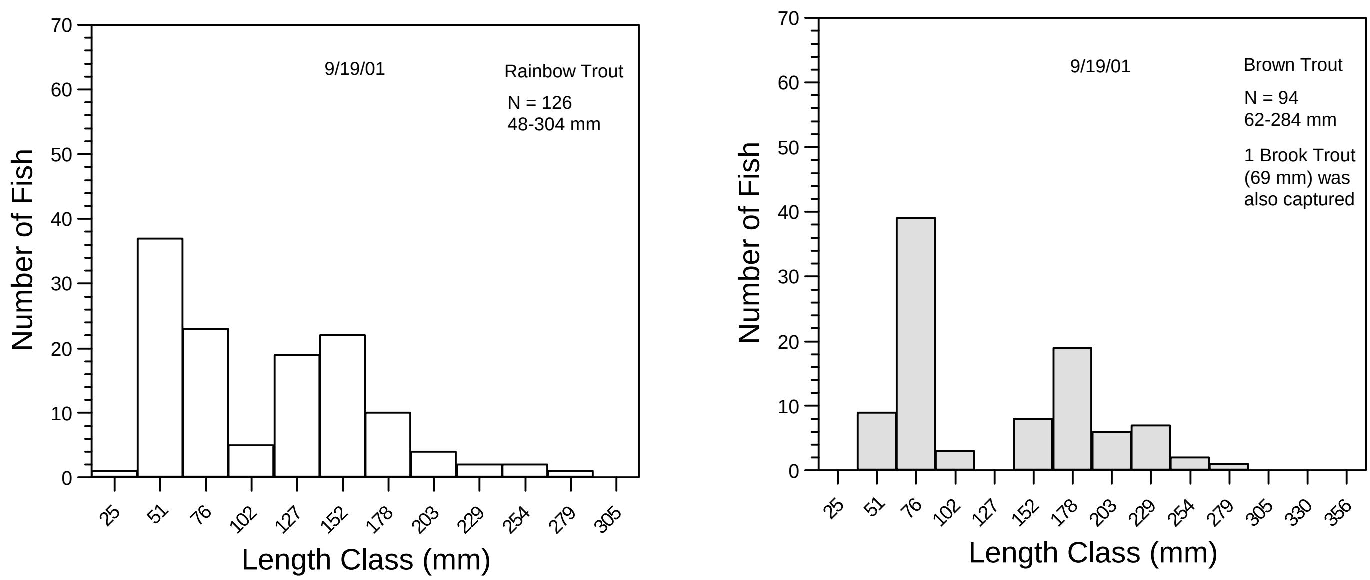


Figure 2-33. Length frequency distributions for rainbow and brown trout from the 2001 Beaverdam Creek samples. Length classes shown (mm) correspond to inch groups (1-12, rainbows; 1-14, browns).

Beaverdam Creek

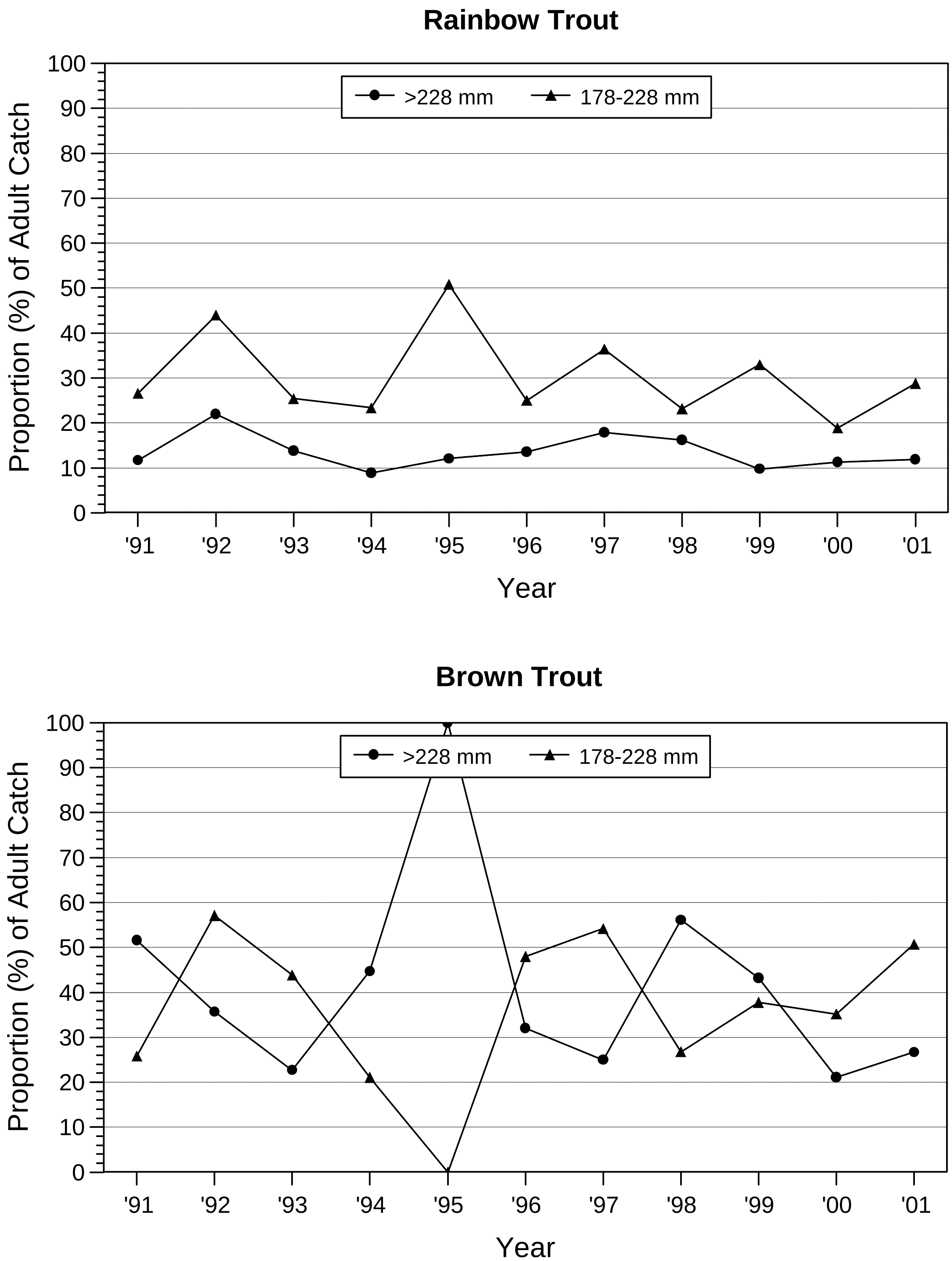


Figure 2-34. Relative abundances of larger rainbow and brown trout at the long-term monitoring stations on Beaverdam Creek.

2.2.8 Laurel Creek

Study Area

Laurel Creek is located in Johnson County, just across the Iron Mountains from Beaverdam Creek. It flows northeast into Virginia where it joins Beaverdam Creek (in Damascus) and becomes a major tributary to the South Fork Holston River. The 3.1-km segment from the state line upstream lies within the CNF. The watershed consists of a mixture of forested, agricultural, and residential lands upstream of the portion on the CNF. Laurel Creek is very similar to Beaverdam Creek in terms of its size, flow, water quality, fish community, and the excellent wild rainbow and brown trout fishery it supports. Six tributaries also contain brook trout populations, five of which are of native, southern Appalachian heritage (Strange and Habera 1997). Although Laurel Creek is one of Tennessee's larger wild trout streams and is readily accessible, it is probably less well known than Beaverdam Creek. Management of this stream includes a put-and-take fishery for hatchery-produced rainbow trout stocked during March through June. Unlike most of Beaverdam Creek, Laurel Creek and its tributaries are subject to general, statewide trout angling regulations, which include a seven-fish creel limit, no bait restrictions, and no size limits for rainbow or brown trout.

Shields' (1950) assessment of Laurel Creek was that it carried more large trout than Beaverdam Creek despite heavy fishing pressure, but natural reproduction was poor, especially for brown trout. Bivens and Williams (1990) qualitatively surveyed Laurel Creek for TWRA in 1989 (just upstream of the state line) and reported good populations of wild rainbow and brown trout with adequate reproduction. Later, quantitative samples were conducted in the lower portion of the stream (near the confluence with Elliot Branch on CNF) in 1993 and in the upper portion (near the confluence of Atchison Branch) in 1994 (Strange and Habera 1994, 1995). Excellent wild trout populations were present in each case, and brown trout standing crop exceeded 100 kg/ha at the upstream site (Strange and Habera 1994). Laurel Creek was added to the long-term monitoring stream set in 2001 to obtain more information about this important wild trout fishery. The 175-m 1993 site was shortened by 10 m on the downstream end for the 2001 sample (Figure 2-35) and will serve as the monitoring station (a fifth electrofishing unit was also added). Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-21.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Laurel Creek station in 2001 are given in Table 2-22. Total trout density in 2001 (827 fish/ha) was 37% lower than in 1993 (1,320 fish/ha), although total trout standing crop (38.29 kg/ha) was somewhat higher than in 1993 (33.08 kg/ha). Brown trout relative abundance increased notably between 1993 and 2001, and this shift may be responsible for the increase in total standing crop despite the overall density decrease. Brown trout, which tend to have higher average weights than rainbows, increased from 30% to 74% of total trout density during 1993-2001 and from 56% to 71% of total trout standing crop during the same period. Additionally, only 4% of all

YOY collected in 1993 were brown trout, while 89% of those collected in 2001 were browns. Similar shifts in the relative abundance of brown trout from mixed populations have been observed recently in other monitoring streams (e.g., Station 2 on Beaverdam Creek and Station 1 on Tellico River) and may be related to the dry conditions prevalent during the past few years.

Length frequency distributions for rainbow and brown trout in 2001 (Figure 2-36) indicated relatively well-balanced population size structures for each species, with several fish in the larger size classes (229 mm and above). The lack of YOY rainbow trout in 2001 was the primary difference compared with the 1993 sample, while for brown trout, YOY and specimens ?305 mm were considerably more abundant in 2001.

Mean backcalculated lengths at age and mean capture lengths for rainbow and brown trout from the 1993 sample, based on scales (Strange and Habera 1994), are given below. Total annual mortality rates have not yet been evaluated for this stream.

	Mean Length at Age				
	0	1	2	3	4
Rainbow (backcalculated)		112	180		
Rainbow (at capture)	74	170	222		
Brown (backcalculated)		124	211	271	305
Brown (at capture)	101	183	260	303	335

Analyses of brown trout otoliths from Laurel Creek in 1996 documented the presence of fish up to age 8. Rainbow trout otoliths will be collected from the Laurel Creek population to better evaluate its age and growth characteristics and to validate scale-derived data.

The mountain redbelly dace present in the 2001 Laurel Creek sample represent the first collection of *Phoxinus oreas* in Tennessee. Jenkins and Burkhead (1993) reported this species from Whitetop Laurel Creek in Virginia (a downstream tributary) and Etnier and Starnes (1993) predicted its eventual appearance in upper East Tennessee. Its presence in Laurel Creek likely represents upstream population expansion or “bait-bucket” introductions since 1993. Most of these specimens will be deposited in the University of Tennessee collection.

Management Recommendations

Laurel Creek supports a wild trout fishery at least as good as the one present in better-known Beaverdam Creek, and future management should feature wild trout. While it should be possible to maintain the traditional put-and-take fishery for stocked rainbow trout without conflict, there should be no expansion of the area or numbers currently stocked. The general angling regulations currently in place can also be maintained; in fact, their presence on Laurel Creek provides evidence that restrictive size limits (e.g., the 229-mm minimum in effect on several streams) are not necessary to sustain viable wild trout populations or to provide quality-sized fish. A creel survey on this stream would provide further enlightenment in this area. Annual sampling at the monitoring station should continue for the next few years in order to add to our understanding of Laurel Creek and of wild trout population dynamics in general.

Laurel Creek Monitoring Station

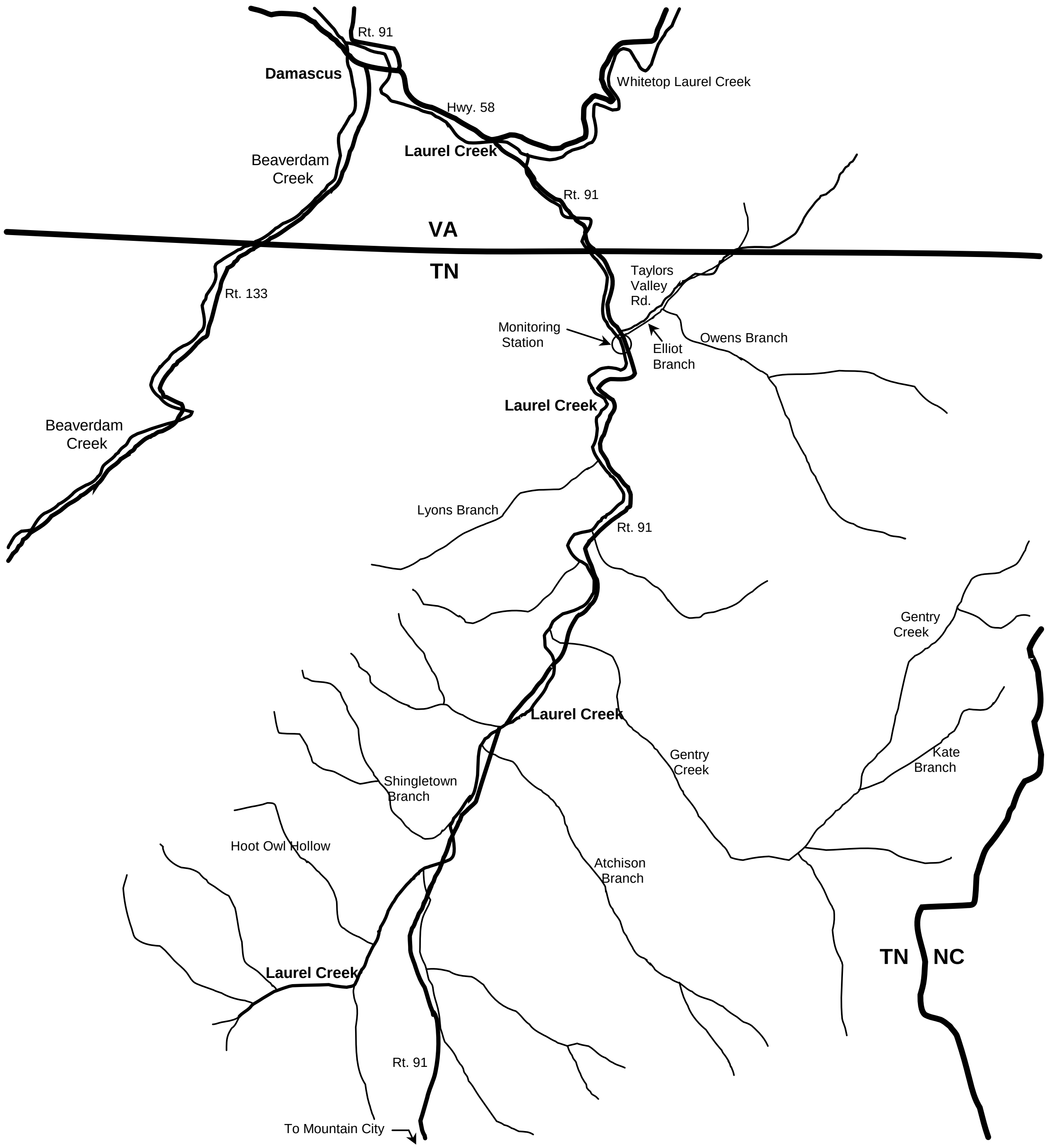


Figure 2-35. Location of the long-term monitoring station on Laurel Creek.

Table 2-21. Site and sampling information for Laurel Creek in 2001.

Location	Station 1	
Site Code	420011501	
Sample Date	04 September	
Watershed	S. Fork Holston River	
County	Johnson	
Quadrangle	Laurel Bloomery 214 SE	
Lat-Long	363606N-814503W	
Reach Number	06010102-25,0	
Elevation (ft)	2,160	
Stream Order	4	
Land Ownership	USFS	
Fishing Access	Excellent	
Description	Site began ~10 m upstream of confluence with Elliot Branch (at wood duck box on LBD). This is the same site (shortened by 10 m on the lower end) that was sampled in 1993.	
Effort		
Station Length (m)	165	
Sample Area (m^2)	2,442	
Personnel	19	
Electrofishing Units	5	
Voltage (AC)	250	
Removal Passes	3	
Habitat		
Mean width (m)	14.8	
Maximum depth (cm)	145	
Canopy cover (%)	50	
Aquatic vegetation	scarce	
Estimated % of site in pools	42	
Estimated % of site in riffles	58	
Visual Hab. Assess. Score	152 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	5	
Sand	15	10
Gravel	15	25
Rubble	20	35
Boulder	25	25
Bedrock	20	5
Water Quality		
Flow (cfs; visual)	normal	
Temperature (C)	18.7	
pH	7.9	
Conductivity (uS/cm)	131	
Dissolved Oxygen (mg/L)	8.9	
Alkalinity (mg/L $CaCO_3$)	65	

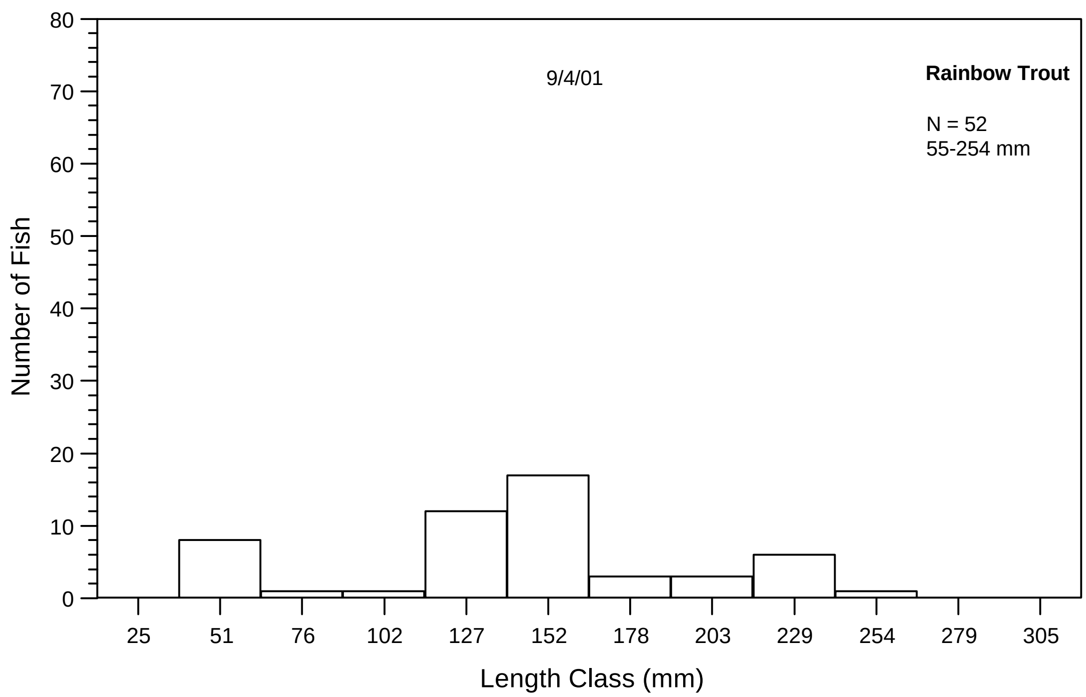
Table 2-22. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Laurel Creek sampled 4 September 2001.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Biomass (g)	Mean Fish Wt. (g)	Standing Crop (kg/ha) Est.	Standing Crop (kg/ha) Lower C.L.	Standing Crop (kg/ha) Upper C.L.	Density (Fish/ha) Est.	Density (Fish/ha) Lower C.L.	Density (Fish/ha) Upper C.L.
Station 1												
RBT <90 mm	9	10	9	16	38	3.8	0.16	0.14	0.25	41	37	66
RBT >90 mm	43	43	43	44	2,650	61.6	10.85	10.85	11.10	176	176	180
BNT <90 mm	75	82	75	92	415	5.1	1.70	1.57	1.92	336	307	377
BNT >90 mm	66	67	66	70	6,247	93.2	25.58	25.19	26.72	274	270	287
Bluegill	12	12	12	14	150	12.5	0.61	0.61	0.72	49	49	57
Longnose dace[1]	2	3	--	--	5	1.5	0.02	--	--	12	--	--
Blacknose dace	79	83	79	89	347	4.2	1.42	1.36	1.53	340	324	364
Mottled sculpin	664	981	839	1,123	4,799	4.9	19.65	16.83	22.53	4,017	3,436	4,599
Warpaint shiner	9	9	9	10	72	8.0	0.29	0.29	0.33	37	37	41
Saffron shiner	245	271	252	290	940	3.5	3.85	3.61	4.16	1,110	1,032	1,188
Creek chub	11	11	11	11	127	11.5	0.52	0.52	0.52	45	45	45
River chub	239	253	241	265	1,449	5.7	5.93	5.63	6.19	1,036	987	1,085
C. stoneroller	331	347	335	359	6,021	17.4	24.66	23.87	25.58	1,421	1,372	1,470
Mt. redbelly dace	5	5	5	8	21	4.2	0.09	0.09	0.14	20	20	33
Fantail darter	108	156	108	210	311	2.0	1.27	0.88	1.72	639	442	860
Snubnose darter	46	57	46	75	98	1.7	0.40	0.32	0.52	233	188	307
Swannanoa darter	1	1	1	1	12	12.0	0.05	0.05	0.05	4	4	4
N. hogsucker	55	55	55	57	3,546	64.5	14.52	14.53	15.06	225	225	233
White sucker	12	12	12	13	656	54.7	2.69	2.69	2.91	49	49	53
Totals	**2,012**	**2,458**	**2,198**	**2,747**	**27,904**		**114.26**	**109.03**	**121.95**	**10,064**	**9,000**	**11,249**

[1]Non-descending removal pattern. Population estimate set equal to 1.5 times total catch (95% confidence limits not calculated).

Note: RBT = rainbow trout and BNT = brown trout. Longnose dace are not included in totals for conficence limits.

Laurel Creek



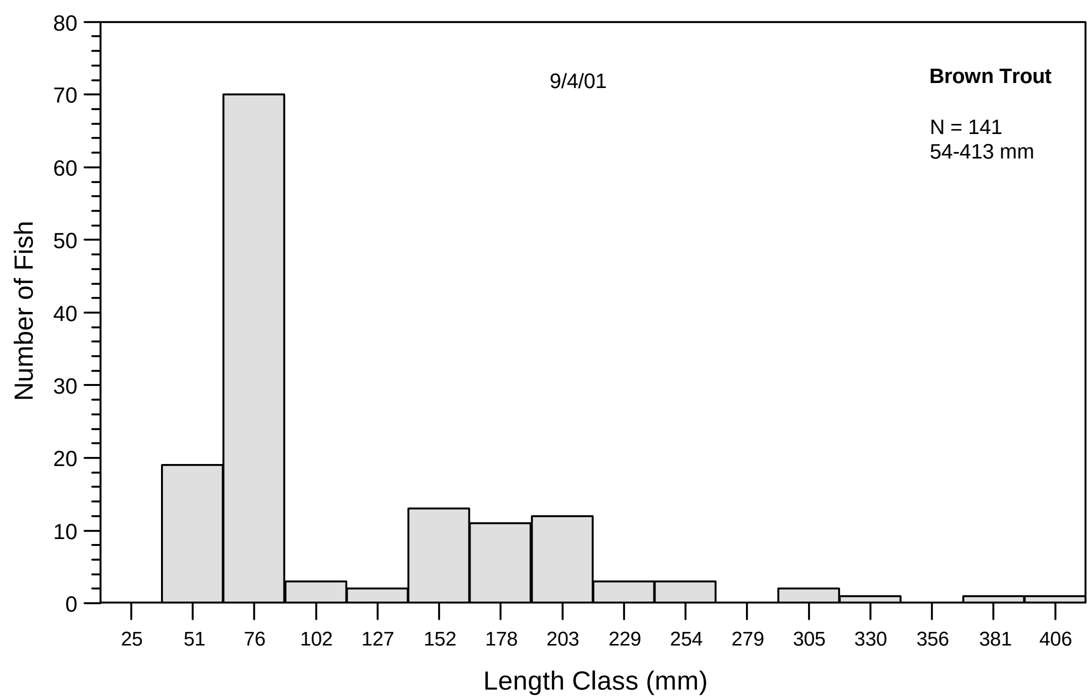


Figure 2-36. Length frequency distributions for rainbow and brown trout from the 2001 Laurel Creek sample. Length classes shown (mm) correspond to inch groups (1-12, rainbows; 1-16, browns).

2.3 SYMPATRIC BROOK/RAINBOW TROUT MONITORING STREAMS

Four streams (upper Rocky Fork, Briar Creek, Birch Branch, and Gentry Creek) are currently being monitored annually with the objective of documenting how (or if) rainbow trout eventually replace brook trout in areas where the two species occur sympatrically. These streams were sampled again in 2001 to continue tracking changes and trends in the relative abundance of each species over time. Upper Doe River has also been part of this monitoring effort, but has not been sampled recently because no brook trout were collected at the station there in 1998 or 1999. The information obtained through this effort should document whether or not rainbow trout are capable of gradually outcompeting and displacing brook trout over time.

2.3.1 Rocky Fork

Study Area

Rocky Fork is part of the general long-term monitoring program (Section 2.2) and was described in Section 2.2.3. The upper portion of Rocky Fork (Figure 2-13, Section 2.2.3) is primarily in Greene County and contains 3.2 km of brook trout water beginning at 914 m (3,000') elevation (Strange and Habera 1997). Shields (1950) reported that upper Rocky Fork, Fort Davie Creek, and Blockstand Creek carried large populations of small brook trout. All subsequent surveys of upper Rocky Fork during the 1960s and 1970s (reviewed by Bivens 1984) documented the presence of excellent brook trout populations, along with wild rainbow trout. Sample site location and effort details, along with habitat and water quality information were summarized in Table 2-10 (Section 2.2.3).

Results and Discussion

Catch data and abundance estimates for trout sampled at Station 2 on Rocky Fork in 2001 were given in Table 2-11 (Section 2.2.3). Total trout abundance has declined substantially at Station 2 since 1997, as it has at several other monitoring stations (Figure 2-14, Section 2.2.3). However, the decline appeared to stabilize somewhat from 2000 to 2001 (Figure 2-14). Population size structures for brook and rainbow trout indicated the presence of YOY for both species (Figure 2-37), although young brook trout were more abundant. Rainbow trout were more abundant than brook trout in the larger size classes (152 mm and up) in 2001 (Figure 2-37), but this has typically been true of all previous samples (Strange and Habera 1997, 1998a; Habera et al. 1999, 2000, 2001a). Nagel and Deaton (1989) questioned the size advantage rainbow trout were thought to hold over brook trout in Rocky Fork's headwaters (as determined by Whitworth and Strange 1983) and elsewhere. However, based on monitoring data from Rocky Fork and other streams, there is little doubt that rainbow trout tend to grow larger than brook trout in a variety of sympatric situations.

The relative abundance of brook trout standing crop was quite stable at about 40% from 1991 through 1993, but began to decline after the flood in early 1994 (Figure 2-38) and associated brook trout year-class failure (Strange and Habera 1995). Rainbow trout appeared to be replacing brook trout at Station 2 on Rocky Fork in 1995, but brook trout abundance recovered to the pre-flood level in 1996 and has even increased since then (Figure 2-38). Brook trout standing crop exceeded that of rainbow trout in 2000 and in 2001, the relative abundance of brook trout (in terms of density and standing crop) surpassed 60% (Figure 2-38). Because rainbow trout have been in this portion of Rocky Fork for many years, it appears that, despite temporary disruptions (e.g., the 1994 flood and current drought), the two species have reached a relative equilibrium in terms of relative abundance.

Management Recommendations

Rocky Fork supports an excellent fishery for wild rainbow and brook trout that future management should seek to maintain. The angling regulations currently in place, which include a 3-fish creel limit for brook trout and no size limit for rainbow trout, are adequate for this purpose. Annual monitoring at Station 2 should continue in order to improve our understanding of sympatric brook and rainbow trout interactions and to gauge the ability of rainbows to replace brook trout. It is recommended that no efforts to remove rainbow trout or enhance brook trout be initiated in upper Rocky Fork while this monitoring is underway so that only natural processes can be studied.

Rocky Fork

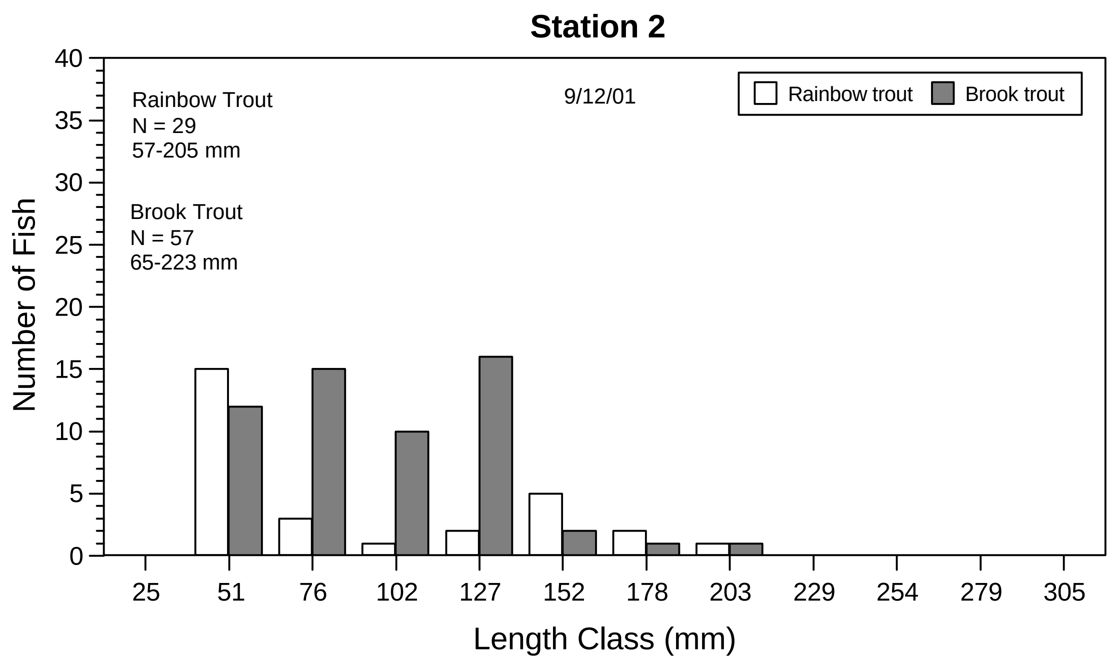


Figure 2-37. Length frequency distributions for brook and rainbow trout from the 2001 Rocky Fork (Station 2) sample. Length classes shown (mm) correspond to inch groups (1-12).

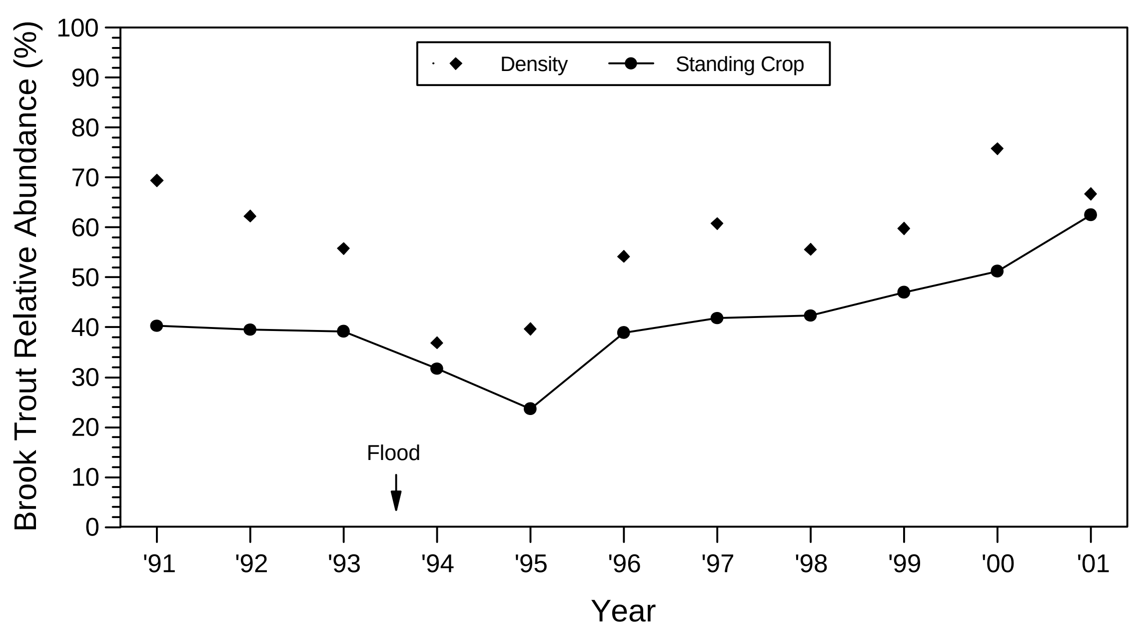


Figure 2-38. Relative brook trout density and standing crop at the monitoring station (2) on Rocky Fork.

2.3.2 Briar Creek

Study Area

Briar Creek is a Nolichucky River tributary in Washington County that flows from Buffalo Mountain through a forested watershed located within the CNF. It contains 4.7 km of brook trout water (southern Appalachian) beginning at an elevation of about 652 m (2,140') (Strange and Habera 1997). Rainbow trout are present throughout the stream to its confluence with Dry Creek. Briar Creek contained only wild rainbow trout until Dr. J. W. Nagel (East Tennessee State University, retired) introduced brook trout in 1983. The rainbow trout population in a 1.37-km reach was thinned by electrofishing during 1983-1986 (598 removed) and 114 southern Appalachian brook trout (mixed ages) were transplanted from East Fork Beaverdam Creek, George Creek, and Tiger Creek during 1983-1984 (Nagel 1986). A reproducing brook trout population became established in the introduction zone by 1986 and had also spread upstream and downstream into areas from which no rainbow trout were removed (Nagel 1991). Briar Creek is subject to general, statewide trout angling regulations.

A station at 662 m (2,170') was quantitatively sampled in 1992 to check the brook trout population status in the original introduction zone (Strange and Habera 1993). This site contained 27% brook trout, but several were removed for genetic analyses (Kriegler et al. 1995). Therefore, a new site (Figure 2-39) was established at 671 m (2,200') and annual monitoring began in 1995 (Strange and Habera 1996). Site location and effort details, along with habitat and water quality information are summarized in Table 2-23.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Briar Creek station in 2001 are given in Table 2-24. Total trout abundance in Briar Creek has decreased substantially since 1997, as it has in Rocky Fork and at several other monitoring stations. Total trout standing crop in 2001 (14.97 kg/ha) was 80% lower than in 1997 (74.33 kg/ha, Strange and Habera 1998a). Population size structures for brook and rainbow trout in 2001 indicated the presence of YOY (Figure 2-40), but the abundance of the new cohort was limited. The strong 1999 brook trout cohort does not appear to have recruited well as there were few fish in the 152-mm size class or larger (Figure 2-40).

Brook trout are now well established and thriving in Briar Creek. Relative abundance at the monitoring station has generally increased since 1995, with brook trout representing the majority of standing crop (50-60%) after 1997 (Figure 2-41). It is unlikely that brook trout will eventually totally replace rainbow trout in any portion of Briar Creek, but it does appear that long-term co-existence is possible.

Management Recommendations

Briar Creek supports a quality wild trout fishery (featuring brook trout) that should be maintained. Annual sampling at the monitoring station should continue in order to improve our understanding of sympatric brook and rainbow trout populations. No efforts to remove rainbow trout or enhance brook trout should occur in upper Briar Fork while this monitoring is underway so that only natural processes can be studied.

Briar Creek Monitoring Station

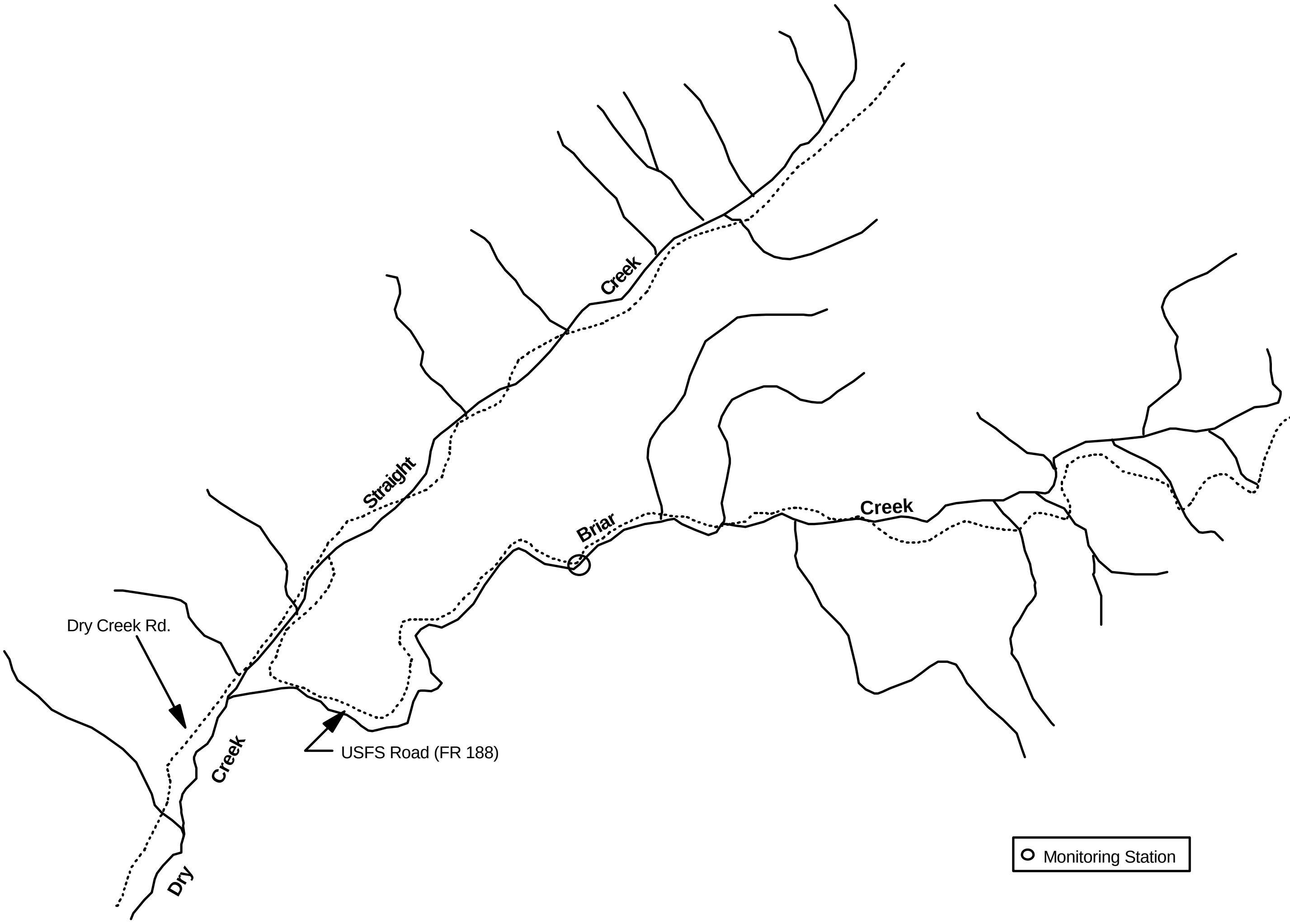


Figure 2-39. Location of the long-term monitoring station in the brook/rainbow trout sympatric zone on Briar Creek.

Table 2-23. Site and sampling information for Briar Creek in 2001

Location	**Station 1**
Site Code	420011301
Sample Date	17 August
Watershed	Nolichucky River
County	Washington
Quadrangle	Erwin 199 NW
Lat-Long	361340N-822325W
Reach Number	06010108
Elevation (ft)	2,200
Stream Order	3
Land Ownership	USFS
Fishing Access	Good
Description	This site is located along the adjacent road (USFS 188) and is marked with a tag on a hemlock on the left stream bank (looking upstream).

Effort	
Station Length (m)	145
Sample Area (m²)	609
Personnel	2
Electrofishing Units	1
Voltage (AC)	600
Removal Passes	3

Habitat	
Mean width (m)	4.2
Maximum depth (cm)	90
Canopy cover (%)	90
Aquatic vegetation	scarce
Estimated % of site in pools	40
Estimated % of site in riffles	60
Visual Hab. Assess. Score	165 (optimal)

Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	5	
Sand	10	5
Gravel	25	35
Rubble	30	40
Boulder	15	20
Bedrock	15	

Water Quality	
Flow (cfs; visual)	normal
Temperature (C)	18.0
pH	6.9
Conductivity (uS/cm)	15
Dissolved Oxygen (mg/L)	--
Alkalinity (mg/L $CaCO_3$)	15

Table 2-24. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Briar Creek sampled 17 August 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
RBT <90 mm	17	17	17	19	63	3.7	1.03	1.03	1.15	279	279	312
RBT >90 mm	8	8	8	8	343	42.9	5.63	5.63	5.64	131	131	131
BKT <90 mm	14	14	14	16	50	3.6	0.82	0.82	0.95	230	230	263
BKT >90 mm	14	14	14	16	456	32.6	7.49	7.49	8.56	230	230	263
Blacknose dace	56	64	56	76	167	2.6	2.74	2.39	3.24	1,051	920	1,248
Totals	**109**	**117**	**109**	**135**	**1,079**		**17.71**	**17.36**	**19.54**	**1,921**	**1,790**	**2,217**

Note: RBT = rainbow trout and BKT = brook trout.

Briar Creek

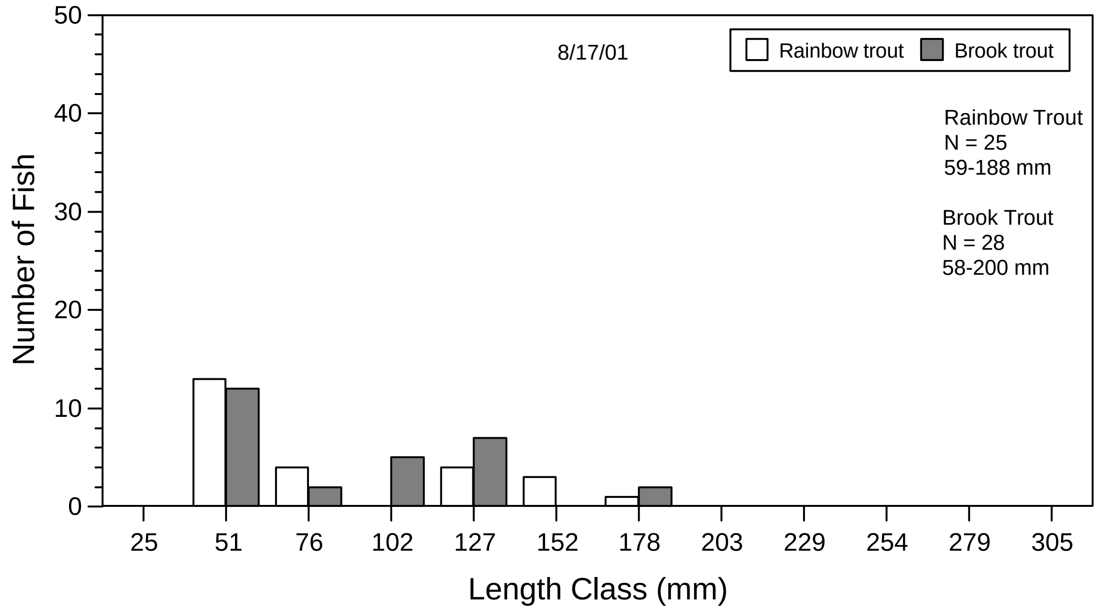


Figure 2-40. Length frequency distributions for brook and rainbow trout from the 2001 Briar Creek sample. Length classes shown (mm) correspond to inch groups (1-12).

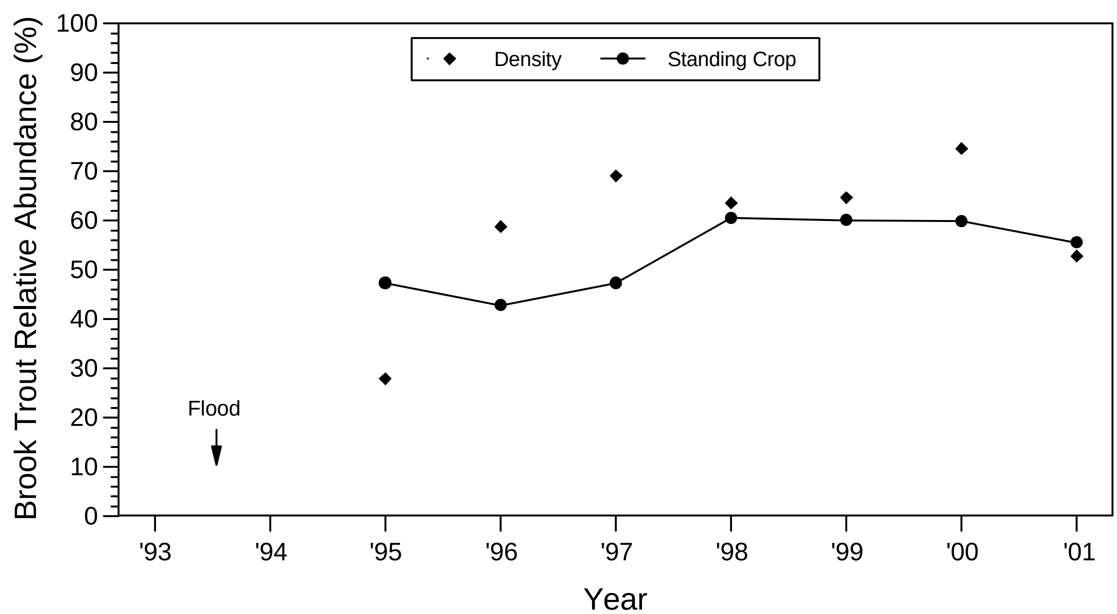


Figure 2-41. Relative brook trout density and standing crop at the monitoring station on Briar Creek.

2.3.3 Birch Branch

Study Area

Birch Branch is a Beaverdam Creek tributary in Johnson County that flows through a mountainous, forested watershed primarily within the CNF (the lower 0.8 km is on private land). It contains 3.9 km of native, southern Appalachian brook trout water beginning at 811 m (2,660') elevation (Strange and Habera 1997). Allopatric brook trout occupy the upper 2.3 km of this distribution (Bivens et al. 1985), followed by a sympatric zone (containing both brook and rainbow trout) and an allopatric rainbow trout zone. Some brown trout may also be present near the confluence with Beaverdam Creek. Birch Branch is subject to general, statewide trout angling regulations.

Birch Branch was surveyed by TWRA in the 1960s and by the USFS in the 1970s to document the presence of brook trout (Bivens 1984). Bivens (1984) recommended construction of a barrier in the lower portion of the stream and removal of rainbow trout to protect the remaining brook trout. This has not been attempted to date and the USFS has no current plans to do so, thus providing an opportunity to monitor population trends in the sympatric zone. A station at 872 m (2,860') containing 97% brook trout was quantitatively sampled during brook trout distribution surveys in 1991 (Strange and Habera 1992). A site further downstream at 823 m (2,700') with more rainbow trout (Figure 2-42) was established and annual monitoring began in 1995 (Strange and Habera 1996). Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-25.

Results and Discussion

Catch data and abundance estimates for trout sampled at the Birch Branch station in 2001 are given in Table 2-26. Total trout standing crop declined 50% from 1997 (19.70 kg/ha) to 1999 (9.69 kg/ha), but has fully recovered since then. Population size structures indicated the presence of YOY of both species, and brook trout reproduction appeared particularly strong (Figure 2-43). The relatively strong 2000 rainbow trout cohort did not appear to recruit particularly well to age 1 and only one fish (a brook trout) ?178 mm was captured (Figure 2-43), but none have been collected at this station since 1998.

No data prior to the flood in 1994 were available from this station, thus relative abundances of brook and rainbow trout at that time are unknown. Brook trout relative abundance in terms of standing crop has generally increased from about 30% in 1995 to over 60% in 2001 (Figure 2-44). Brook trout became the dominant species (in terms of standing crop) in 2000 and expanded this advantage in 2001.

Management Recommendations

Birch Branch supports a wild trout fishery which future management should maintain. Continued monitoring at the Birch Branch station will be necessary to further understand brook and rainbow trout interactions in sympatry and to gauge the ability of rainbows to replace brook trout. The monitoring station is located on private land, but it is recommended that no efforts to remove rainbow trout or enhance brook trout be undertaken elsewhere in Birch Branch while this monitoring is underway so that only natural processes can be studied.

Birch Branch Monitoring Station

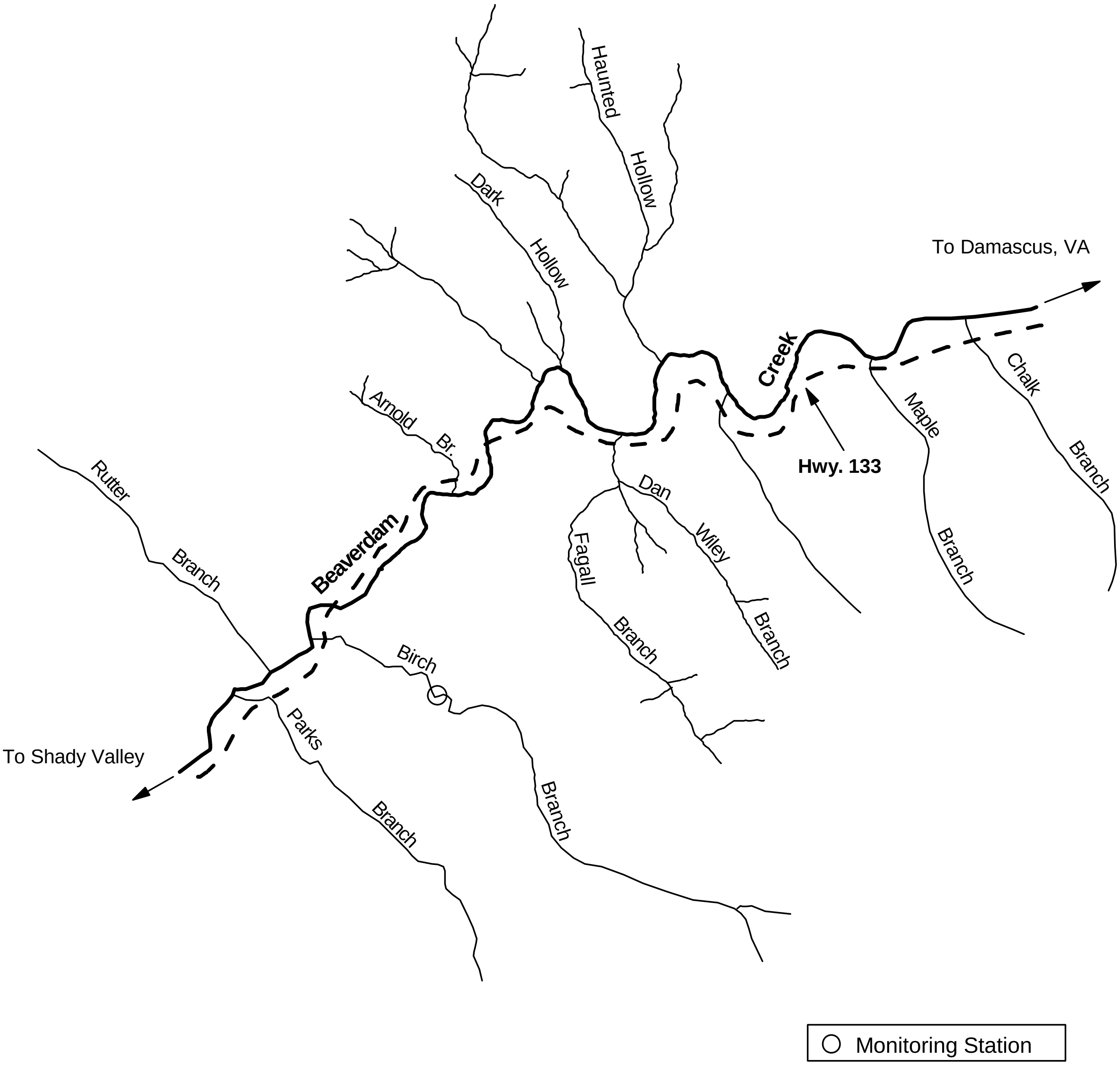


Figure 2-42. Location of the long-term monitoring station in the brook/rainbow trout sympatric zone on Birch Branch.

Table 2-25. Site and sampling information for Birch Branch in 2001.

Location	Station 1	
Site Code	420011001	
Sample Date	03 July	
Watershed	S. Fork Holston River	
County	Johnson	
Quadrangle	Laurel Bloomery 213 SE	
Lat-Long	363325N-815210W	
Reach Number	06010102	
Elevation (ft)	2,700	
Stream Order	2	
Land Ownership	Private	
Fishing Access	Good	
Description	This monitoring station ends at the USFS boundary markers (at first trail crossing).	
Effort		
Station Length (m)	130	
Sample Area (m²)	494	
Personnel	2	
Electrofishing Units	1	
Voltage (AC)	450	
Removal Passes	3	
Habitat		
Mean width (m)	3.8	
Maximum depth (cm)	72	
Canopy cover (%)	95	
Aquatic vegetation	scarce	
Estimated % of site in pools	31	
Estimated % of site in riffles	69	
Visual Hab. Assess. Score	159 (suboptimal)	
Substrate Composition	Pool (%)	Riffle (%)
Silt	15	
Sand	10	5
Gravel	20	25
Rubble	45	60
Boulder	10	10
Bedrock		
Water Quality		
Flow (cfs; visual)	normal	
Temperature (C)	16.3	
pH	6.6	
Conductivity (uS/cm)	12	
Dissolved Oxygen (mg/L)	--	
Alkalinity (mg/L $CaCO_3$)	10	

Table 2-26. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Birch Branch sampled 3 July 2001.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Biomass (g)	Mean Fish Wt. (g)	Standing Crop (kg/ha) Est.	Standing Crop (kg/ha) Lower C.L.	Standing Crop (kg/ha) Upper C.L.	Density (Fish/ha) Est.	Density (Fish/ha) Lower C.L.	Density (Fish/ha) Upper C.L.
RBT <90 mm	13	14	13	19	5	0.4	0.10	0.11	0.15	283	263	385
RBT >90 mm	18	18	18	19	360	20.0	7.29	7.29	7.69	364	364	385
BKT <90 mm	43	44	43	48	129	2.9	2.61	2.52	2.82	891	870	972
BKT >90 mm	24	24	24	25	547	22.8	11.07	11.08	11.54	486	486	506
Totals	**98**	**100**	**98**	**111**	**1,041**		**21.07**	**21.00**	**22.20**	**2,024**	**1,983**	**2,248**

Note: RBT = rainbow trout and BKT = brook trout.

Birch Branch

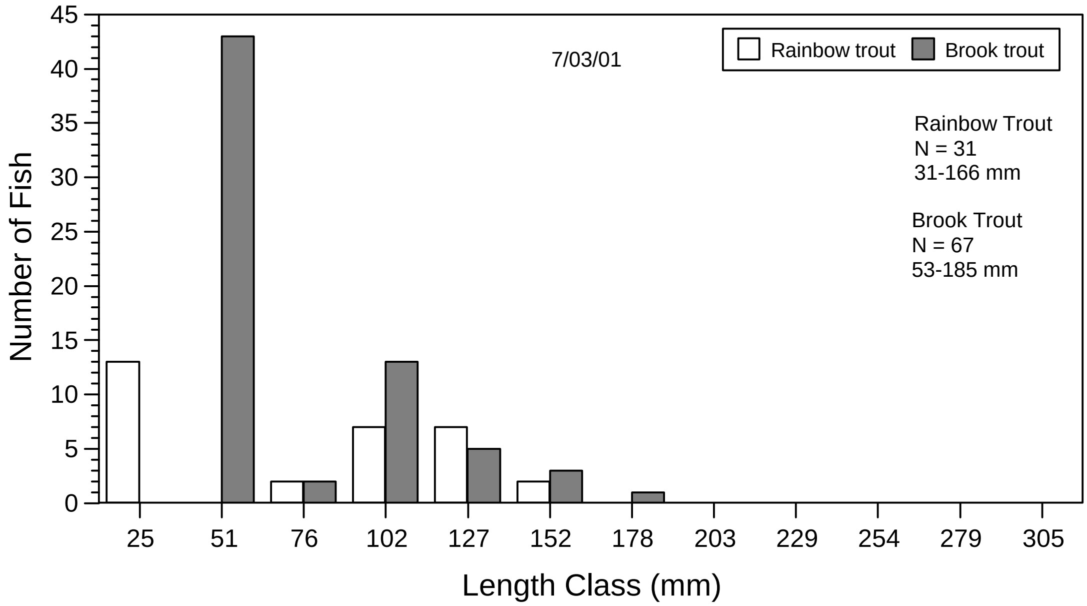


Figure 2-43. Length frequency distributions for brook and rainbow trout from the 2001 Birch Branch sample. Length classes shown (mm) correspond to inch groups (1-12).

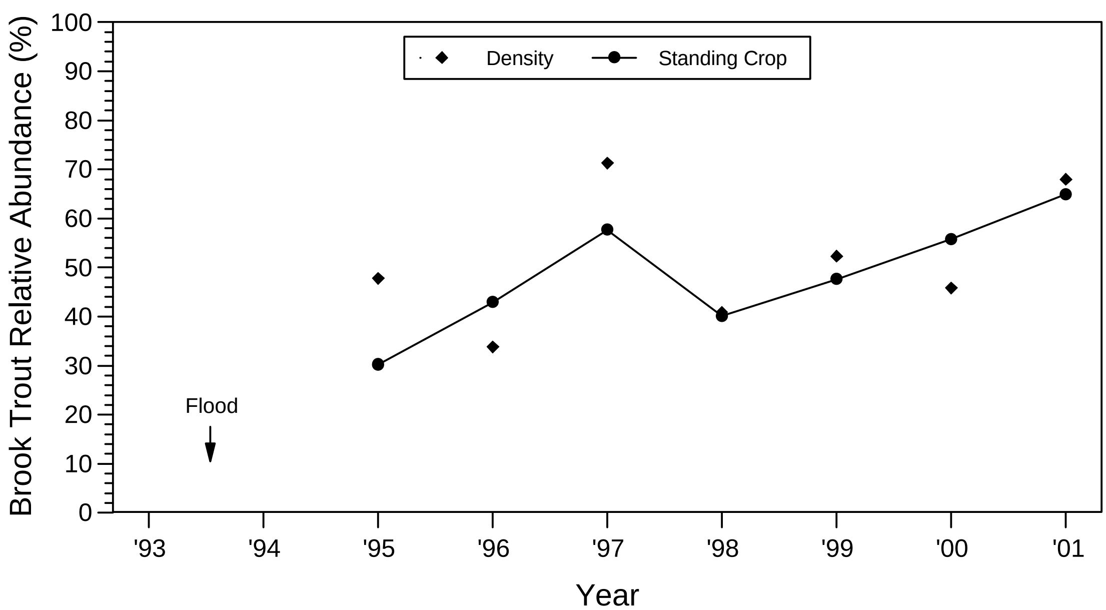


Figure 2-44. Relative brook trout density and standing crop at the monitoring station on Birch Branch.

2.3.4 Gentry Creek

Study Area

Gentry Creek is a tributary of Laurel Creek in Johnson County and flows through a mountainous, forested watershed primarily within the CNF. It has about 6.5 km of brook trout water beginning at 826 m (2,710') elevation (Strange and Habera 1997). Allopatric, southern Appalachian brook trout inhabit the stream above a large falls at about 1,024 m (3,360'). Below the falls is a 4.3-km section containing both brook and rainbow trout. Downstream (from the USFS boundary to the confluence with Laurel Creek), rainbow trout predominate, although a few brook trout and some brown trout may be present. All of Gentry Creek's named tributaries from Grindstone Branch upstream (i.e., Cut Laurel Branch, Kate Branch, and Gilbert Branch) also have brook trout populations (Strange and Habera 1997). Like Gentry Creek, all tributary brook trout populations consist of southern Appalachian fish. The entire watershed is currently under general statewide trout angling regulations.

Gentry Creek was surveyed by TWRA in the 1960s and by the USFS in the 1970s to document the presence of brook trout (reviewed by Bivens 1984). Bivens (1984) recommended that a barrier be constructed below Grindstone Branch and rainbow trout removed from the area upstream. This has not been attempted to date and the USFS has no current plans to do so, thus providing an opportunity to monitor population trends in the sympatric zone. A station at 963 m elevation (3,160') in the sympatric zone was sampled in 1992 (Figure 2-45; Strange and Habera 1994) and was added to the annual monitoring program in 1996. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-27.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Gentry Creek station in 2001 are given in Table 2-28. Population size structures indicated another strong brook trout cohort in 2001 (Figure 2-46). Recruitment of the relatively strong 2000 brook trout cohort was indicated by the abundance of fish in the 102-m size class in 2001 (34) as compared to 2000 (12). Additionally, recruitment from the abundant 1999 brook trout cohort appeared to produce some fish in the larger size classes (?178 mm; Figure 2-46). No brook trout of this size were present in 2000 and only one was captured in 1999 (Habera et al. 2001a, 2000). Three of the four fish ?178 mm in 2001 were brook trout (Figure 2-46), although in previous samples from Gentry Creek, as well as those from other sympatric populations, most of the larger fish tended to be rainbows. A few age-0 rainbow trout were collected in 2001 (Figure 2-46), but these fish are typically quite small (<50 mm) and just beginning to recruit to the sampling gear at this time of year.

Two floods occurred in this watershed after the 1992 sample. Trout abundance had changed from predominantly brook trout to predominantly rainbow trout when the next sample was conducted in 1996 (Figure 2-47). Floods have been implicated in the alteration of species composition in favor of rainbow trout when they occur sympatrically with brook trout (Seegrist and Gard 1972; Nagel 1991) and this may have happened in Gentry Creek. Brook trout relative abundance exceeded 50% again in 1997, declined in 1998, and has steadily increased since then (Figure 2-47). Brook trout regained dominance in 2000, and their relative abundance in 2001 was higher than in any previous sample. The relative abundance of sympatric brook trout in Rocky Fork recovered rather quickly after the 1994 flood (Section 2.3.1) and despite floods in two consecutive years, it appears that Gentry Creek's brook trout have also recovered and are capable of long-term coexistence with rainbow.

Management Recommendations

Gentry Creek supports a quality wild trout fishery which future management should seek to maintain and emphasize. Continued monitoring at the Gentry Creek station will be necessary to further understand brook and rainbow trout interactions in sympatry and to gauge the ability of rainbows to replace brook trout. It is recommended that no efforts to remove rainbow trout or enhance brook trout be initiated in Gentry Creek while this monitoring is underway so that only natural processes can be studied.

Gentry Creek Monitoring Station

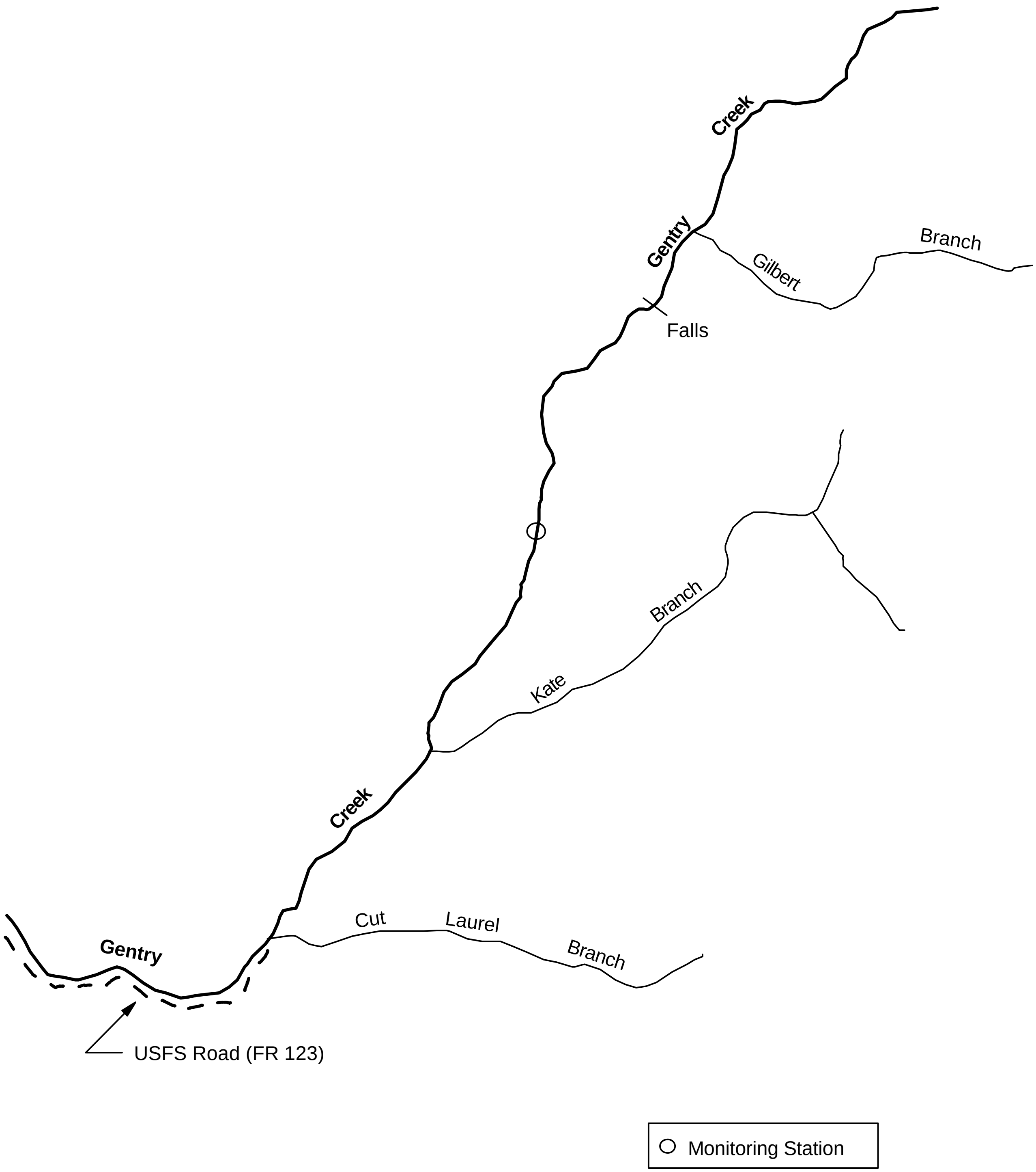


Figure 2-45. Location of the long-term monitoring station in the brook/rainbow trout sympatric zone on Gentry Creek.

Table 2-27. Site and sampling information for Gentry Creek in 2001.

Location	**Station 1**
Site Code	420010801
Sample Date	19 June
Watershed	S. Fork Holston River
County	Johnson
Quadrangle	Grayson 219 SW
Lat-Long	363300N-814235W
Reach Number	06010102-27,0
Elevation (ft)	3,160
Stream Order	2
Land Ownership	USFS
Fishing Access	Good
Description	This monitoring station ends at the eighth crossing by the adjacent trail (beginning at the parking area near Cut Laurel Branch).

Effort	
Station Length (m)	119
Sample Area (m²)	428
Personnel	2
Electrofishing Units	1
Voltage (AC)	450
Removal Passes	3

Habitat	
Mean width (m)	3.6
Maximum depth (cm)	72
Canopy cover (%)	85
Aquatic vegetation	scarce
Estimated % of site in pools	34
Estimated % of site in riffles	66
Visual Hab. Assess. Score	166 (optimal)

Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	5	
Sand	10	10
Gravel	40	40
Rubble	30	30
Boulder	15	20
Bedrock		

Water Quality	
Flow (cfs; visual)	normal
Temperature (C)	15.3
pH	6.5
Conductivity (uS/cm)	14
Dissolved Oxygen (mg/L)	--
Alkalinity (mg/L $CaCO_3$)	10

Table 2-28. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Gentry Creek sampled 19 June 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
RBT <90 mm	4	4	4	7	9	2.2	0.21	0.21	0.36	94	94	165
RBT >90 mm	13	13	13	13	512	39.4	12.05	12.05	12.05	306	306	306
BKT <90 mm	43	57	43	82	89	1.6	2.09	1.62	3.09	1,341	1,012	1,929
BKT >90 mm	57	57	57	58	1,211	21.2	28.49	28.49	28.93	1,341	1,341	1,365
Mottled sculpin	92	114	92	139	617	5.4	14.52	11.69	17.66	2,682	2,165	3,271
Totals	**209**	**245**	**209**	**299**	**2,438**		**57.36**	**54.06**	**62.09**	**5,764**	**4,918**	**7,036**

Note: RBT = rainbow trout; BKT = brook trout.

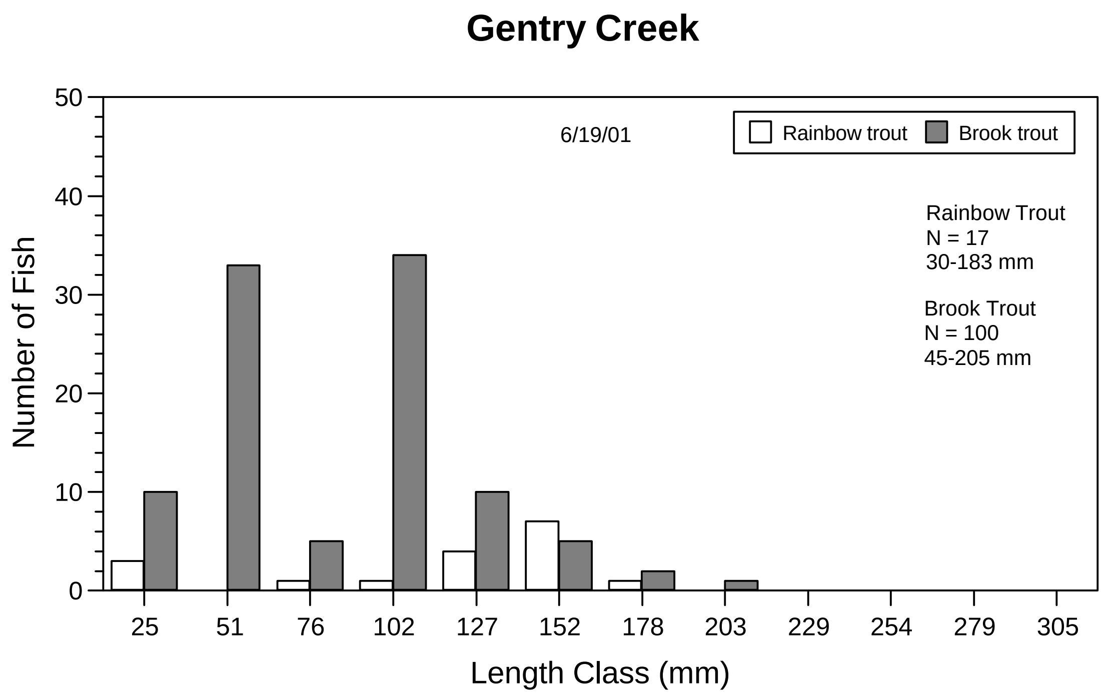


Figure 2-46. Length frequency distributions for brook and rainbow trout from the 2001 Gentry Creek sample. Length classes shown (mm) correspond to inch groups (1-12).

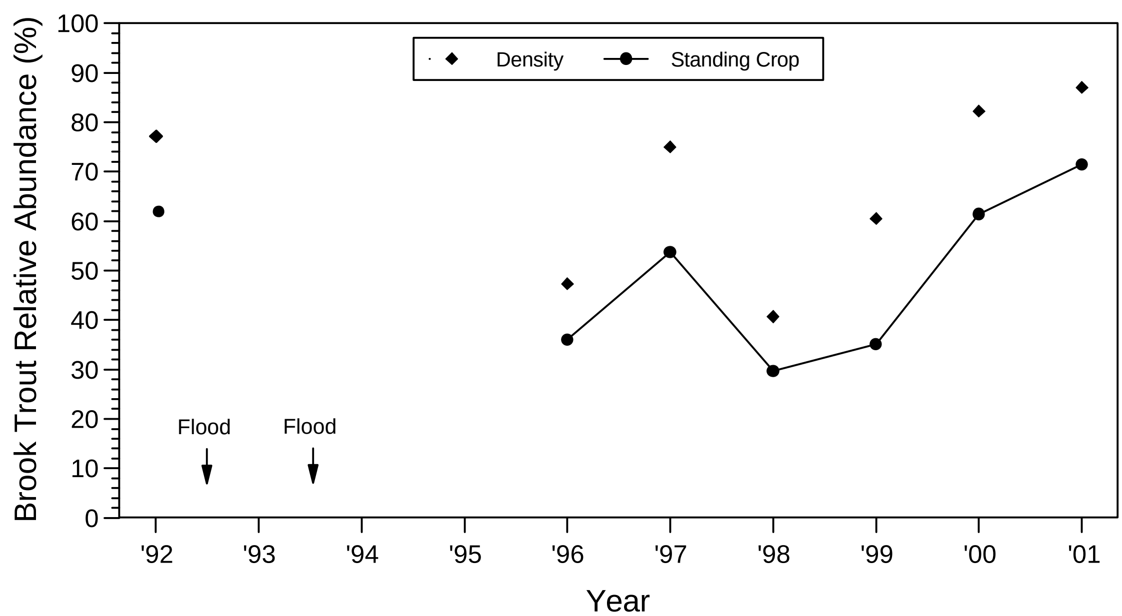


Figure 2-47. Relative brook trout density and standing crop at the monitoring station on Gentry Creek. No data were collected during 1993-1995.

2.3.5 Summarization

Inventories of all Tennessee brook trout streams outside GSMNP revealed some fluctuation since the early 1980s, but no net loss of brook trout distribution (on the downstream end) in streams where they are sympatric with rainbow trout (Strange and Habera 1997; Strange and Habera 1998b). Larson and Moore (1985) predicted an ebb and flow of brook and rainbow trout within sympatric zones based on interactions of biotic and abiotic factors, and later, Larson et al. (1995) observed such fluctuation in a GSMNP stream over several years. Data from other Tennessee streams suggest this fluctuation may be typical, thus the boundaries of a sympatric zone could shift up or down annually and the lower limit of brook trout or upper limit of rainbow trout could depend largely on the year in which a particular stream is sampled.

If rainbow trout are capable of completely replacing an established brook trout population in a given stream, then their entrance (through colonization or stocking) must eventually be followed by an expansion of abundance to a point where brook trout are eliminated. Data from the monitoring stations discussed above continue to suggest that rainbow trout may have no particular competitive advantage and could exist for many years at some "equilibrium" with brook trout. Replacement of brook trout might only be possible through opportunism, such as a succession of late winter/early spring floods that severely weaken or eliminate brook trout year classes (rainbow trout cohorts are affected less; Strange and Habera 1995, 1996).

Clark and Rose (1997) recognized that replacement of brook trout by rainbow trout has not been explained by the conventional theory involving a niche shift induced by the presence of a superior competitor. Their modeling documented the importance of year-class failures (e.g., those caused by floods), but predicted that rainbows would not replace brook trout if such failures occurred infrequently (intervals of 10-20 years). Even with year-class failures at 3-year intervals, it required 80 years for a simulated brook trout population to be eliminated. However, Nagel (1991) modeled small, isolated brook trout populations for 30-year periods and reported high probabilities of extinction (56% for 2.5-km streams, 92% for 0.5-km streams) with year class failures at 5-year intervals and no sympatric rainbow trout.

TWRA's monitoring indicates that trout year class failures related to floods or other events probably occur, on average, at an interval of between 3 and 10 years, but the local extinction probabilities projected by Nagel (1991) have not been observed (Strange and Habera 1998b). Additionally, while Larson et al. (1995) observed fluctuations in rainbow trout density over a 14-year period (which included a large flood) and they displaced brook trout at times as the most abundant species in the lower part of the study stream, brook trout were never eliminated. Furthermore, Clark and Rose (1997) included both species when a year-class failure occurred in their simulations, but typical late-winter/early spring floods would likely affect only brook trout reproduction. This could be expected to provide long-term advantages for rainbows, as might have been the case in upper Doe River (Habera et al. 2000), but monitoring data from Rocky Fork and Gentry Creek suggest no such benefit. Therefore, it would seem to require an unusual circumstance (perhaps three of four successive year-class failures) to facilitate replacement or extinction of brook trout populations. It remains unclear what conditions or events (if any) enable rainbow trout to eventually eliminate brook trout, thus monitoring at the four stations discussed above (and occasionally Doe River) should continue. However, the current outlook for Tennessee's brook trout populations is much more positive than it was a decade ago (Habera et al. 2001b).

2.4 OTHER STREAMS

These streams or stream segments typically have not previously been sampled (quantitatively), although qualitative surveys may have been conducted (e.g., to check for brook trout). The primary sampling objective was to document species composition and abundance and supplement the existing wild trout database.

2.4.1 Trail Fork of Big Creek

Study Area

Big Creek is a tributary to the French Broad River at Del Rio in Cocke County. It splits into two major branches (Gulf Fork and Trail Fork) about 400 m upstream from the confluence with the French Broad. Trail Fork Big Creek arises near Lemon Gap between Rich and Laurel Mountains along the boundary between Cocke County and Madison County, North Carolina. Most of the upper half of the stream is located within the CNF. The lower portion flows through a privately owned watershed characterized by a mixture of forested, agricultural, and residential areas. This stream is subject to general statewide trout angling regulations and, except for a few years recently when there were water quality problems, TWRA has annually stocked (March-May) the lower portion with catchable-size rainbow trout. Its fishing pressure probably comes primarily from local residents. Shields (1950) reported that trout reproduction was good in Lemon Gap (Prong) and Boomer Creek (headwaters of Trail Fork Big Creek) and considered Trail Fork to be a fair trout stream down to Nough, below which it became to warm and silty for trout. A quantitative sample of upper Trail Fork (3,020') was conducted in 1996 (Strange and Habera 1997) to obtain wild trout population data. A site farther downstream, near Blue Mill, was selected and sampled in 2001 (Figure 2-48) to document wild trout abundance in this portion of the stream. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-29.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Trail Fork Big Creek site in 2001 are given in Table 2-30. A wild rainbow trout population of about average abundance (22 kg/ha) was present, along with several non-salmonid species typical of other Tennessee trout streams. The 1996 sample of Trail Fork (~6.7 km upstream) produced only wild rainbow trout and abundance was lower (14 kg/ha). Natural reproduction during the previous spawning season was quite successful as indicated by the abundance of YOY in 2001 (Figure 2-49). Some harvestable fish (>178 mm) were also present, but adult abundance was somewhat limited (Figure 2-49). This could be related to the dry conditions prevalent during the past few years, although basic recruitment potential may be limited in Trail Fork as adult abundance and size distribution was relatively similar for the 1996 sample.

Benthic macroinvertebrates collected at the Trail Fork Big Creek site comprised 30 families representing 34 identified genera (Table 2-31). The most abundant organisms were caddisflies, stoneflies, and mayflies, which together represented about 76% of the sample. Total taxa richness was 42 and EPT taxa richness was 23. Based on the EPT taxa richness value and the overall biotic index at this site, the relative health of the benthic community was classified as fair/good - good.

Management Recommendations

Although the hatchery-supported trout fishery in the lower portion of Trail Fork is probably more important to local anglers at this time, the upper part of this stream supports a viable wild rainbow trout population that should be maintained. Another sample at this site might be obtained some time after the current drought conditions subside to determine if this part of Trail Fork is capable of producing and supporting more adult wild rainbows. No changes in the current management status of Trail Fork are recommended.

Trail Fork Big Creek Sample Station

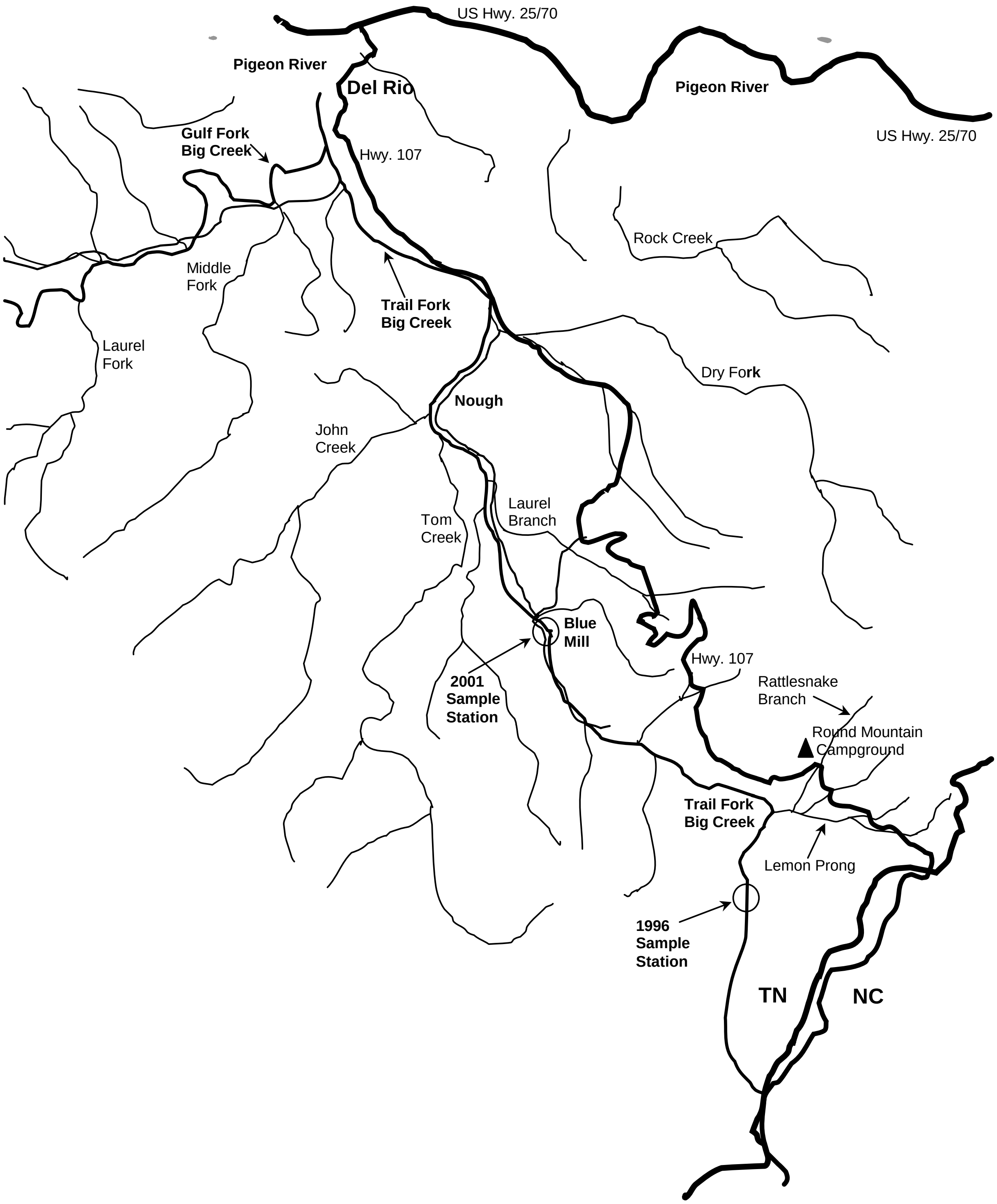


Figure 2-48. Location of the 2001 sample station on Trail Fork Big Creek.

Table 2-29. Site and sampling information for Trail Fork Big Creek in 2001.

Location	**Station 1**	
Site Code	420011901	
Sample Date	12 October	
Watershed	French Broad River	
County	Cocke	
Quadrangle	Lemon Gap 182 SW	
Lat-Long	355107N-825938W	
Reach Number	06010105-5,1	
Elevation (ft)	1,680	
Stream Order	3	
Land Ownership	Private/USFS	
Fishing Access	Good	
Description	Begins ~50 m downstream of powerline crossing of Norwood Town Road (adjacent to the creek). The Trail Fork Big Creek bridge at Blue Mill is ~450 m downstream.	
Effort		
Station Length (m)	125	
Sample Area (m²)	713	
Personnel	4	
Electrofishing Units	2	
Voltage (AC)	400	
Removal Passes	3	
Habitat		
Mean width (m)	5.7	
Maximum depth (cm)	82	
Canopy cover (%)	80	
Aquatic vegetation	scarce	
Estimated % of site in pools	29	
Estimated % of site in riffles	71	
Visual Hab. Assess. Score	154 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	5	
Sand	20	5
Gravel	25	30
Rubble	25	35
Boulder	25	30
Bedrock		
Water Quality		
Flow (cfs; visual)	3.0; normal	
Temperature (C)	14.3	
pH	7.0	
Conductivity (uS/cm)	26	
Dissolved Oxygen (mg/L)	9.3	
Alkalinity (mg/L $CaCO_3$)	15	

Table 2-30. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Trail Fork Big Creek sampled 12 October 2001.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Biomass (g)	Mean Fish Wt. (g)	Standing Crop (kg/ha) Est.	Standing Crop (kg/ha) Lower C.L.	Standing Crop (kg/ha) Upper C.L.	Density (Fish/ha) Est.	Density (Fish/ha) Lower C.L.	Density (Fish/ha) Upper C.L.
Station 1												
RBT <90 mm	95	104	95	115	505	4.9	7.08	6.53	7.90	1,459	1,332	1,613
RBT >90 mm	34	34	34	35	1,054	31.0	14.78	14.78	15.22	477	477	491
Longnose dace	25	53	25	145	678	12.8	9.51	4.49	26.03	743	351	2,034
Blacknose dace	94	98	94	104	391	4.0	5.48	5.27	5.83	1,374	1,318	1,459
Mottled sculpin	155	227	160	294	1,245	5.5	17.46	12.34	22.68	3,184	2,244	4,123
Stoneroller	1	1	1	1	75	75.0	1.05	1.05	1.05	14	14	14
Fantail darter	8	13	8	40	49	3.8	0.69	0.43	2.13	182	112	561
Totals	**412**	**530**	**417**	**734**	**3,997**		**56.05**	**44.89**	**80.84**	**7,433**	**5,848**	**10,295**

Note: RBT = rainbow trout.

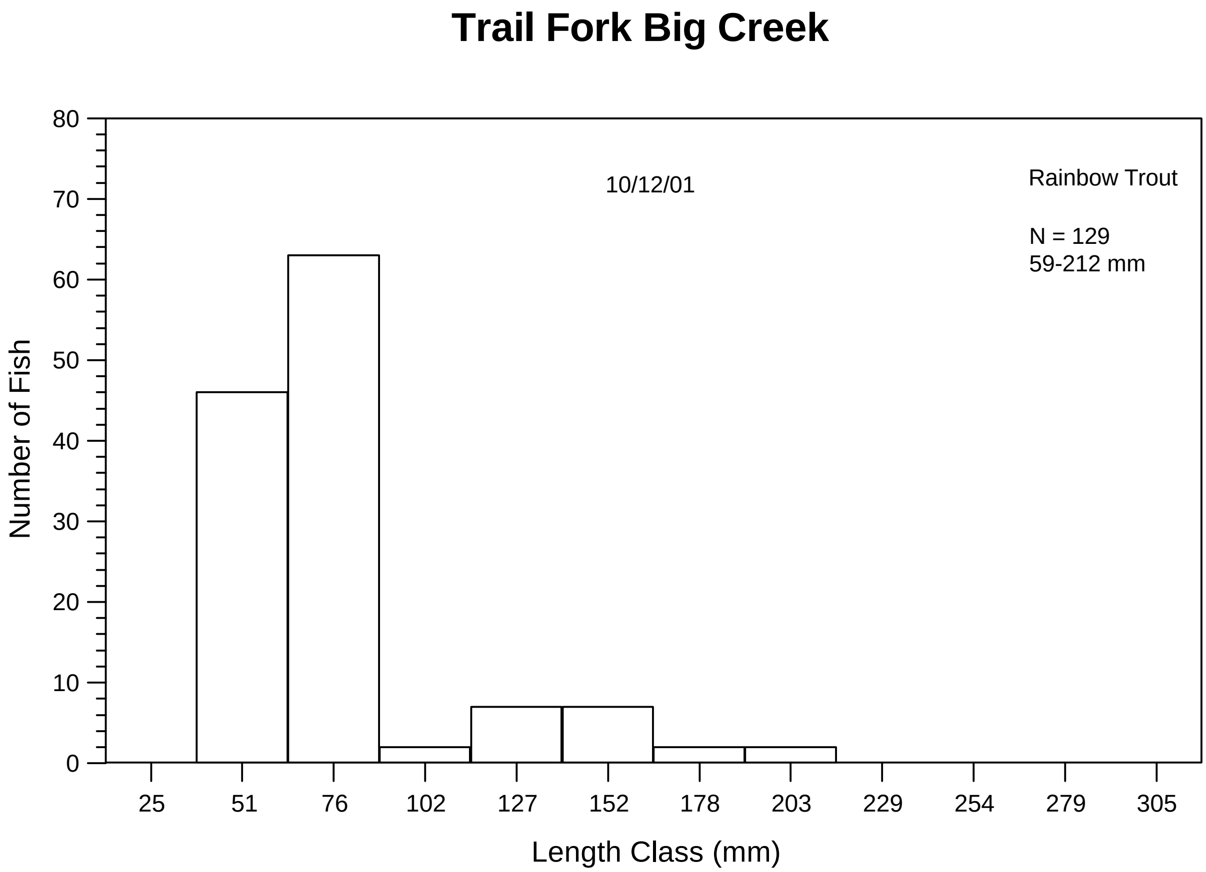


Figure 2-49. Length frequency distributions for rainbow trout from the 2001 Trail Fork Big Creek sample. Length classes shown (mm) correspond to inch groups (1-12).

Table 2-31. Benthic organisms sampled at Trail Fork Big Creek in 2001 (Field # RDB-2001-29). Total sampling effort was 3 h.

Order	Family	*Genus / species*	Number	Percent
ANNELIDA				0.3
	Oligochaeta		1	
COLEOPTERA				4.0
	Elmidae	*Optioservus ovalis* larva and adults	8	
		Promoresia tardella larvae and adults	6	
	Eubriidae	*Ectopria*	1	
	Psephenidae	*Psephenus herricki*	1	
DIPTERA				14.1
	Athericidae	*Atherix lantha*	4	
	Blephariceridae	*Blephariceral*	9	
	Chironomidae		5	
	Dixidae	*Dixa*	1	
	Simuliidae		31	
	Tipulidae	*Hexatoma*	5	
		Tipula	1	
EPHEMEROPTERA				18.1
	Baetidae	*Baetis*	36	
	Ephemerellidae	*Ephemerella*	2	
	Heptageniidae	*Epeorus dispar*	7	
		Stenonema early instars	18	
	Isonychiidae	*Isonychia*	2	
	Leptophlebiidae	*Paraleptophlebia*	7	
GASTROPODA				4.3
	Ancylidae	*Ferrissia*	1	
	Pleuroceridae	elongated form w/ dark stripe prominent on last spiral	16	
HETEROPTERA				0.3
	Gerridae	*Gerris remigis* female	1	
MEGALOPTERA				0.5
	Corydalidae	*Nigronia serricornis*	2	
ODONATA				1.0
	Cordulegastridae	*Cordulegaster eronea*	1	
	Gomphidae	*Lanthus vernalis*	1	
		Stylogomphus albistylus	2	
PLECOPTERA				27.0
	Chloroperlidae	*Sweltsa*	1	
	Peltoperlidae	*Peltoperla*	53	
	Perlidae	*Acroneuria abnormis*	5	
		Paragnetina immarginata	7	
	Perlodidae	*Malirekus hastatus*	13	
	Pteronarcyidae	*Pteronarcys (Allonarcys)*	28	
TRICHOPTERA				30.5
	Apataniidae	*Apatania*	1	
	Hydropsychidae	*Arctopsyche irrorata*	1	
		Ceratopsyche macleodi	10	
		Ceratopsyche slossonae	9	
		Ceratopsyche sparna	20	
		Diplectrona modesta	16	
	Philopotamidae	*Dolophilodes distinctus*	55	
	Rhyacophilidae	*Rhyacophila carolina*	1	
		Rhyacophila fuscula	3	
		Rhyacophila sp.	2	
	Uenoidae	*Neophylax* pupae	3	
TOTAL			397	100.0

Taxa richness = 42; EPT taxa richness = 23; bioclassification = 3.8 (Fair/Good - Good).

2.4.2 Upper Laurel Fork

Study Area

Laurel Fork is one of Tennessee's better wild trout steams and two stations on this stream were monitored annually during 1991-2000 (Habera et al. 2001a). Most of Laurel Fork lies within the CNF, although there is nearly 4 km of stream on private land above the upper Forest Service boundary at about 1,000 m elevation (3,280'). This portion of the Laurel Fork watershed is mountainous and much of it is forested, although there is also a substantial amount of silvicultural activity (Christmas tree farming), along with some agricultural and residential land use as well. Shields (1950) does not specifically address the uppermost segment of Laurel Fork, but does describe degraded instream habitat near the confluence of Little Laurel Fork (~8 km below upper USFS boundary) related to eroded stream banks and heavy siltation of the streambed. Tatum (1968) reported brook trout for the headwaters of Laurel Fork, but attributed the low abundance at that time to erosion caused by forest fires and logging. Whitworth and Strange (1979) later found only dace in heavily silted upper Laurel Fork and judged it unsuitable for trout management. A qualitative survey of upper Laurel Fork in 1997 revealed the presence of wild brook and brown trout up to the road crossing at 1,021 m (3,350'), near the upper limit of fish habitat.

Because of the observation of wild trout in upper Laurel Fork in 1997, a quantitative sample site was planned for this stream. A site ~1 km upstream of the upper USFS boundary (Figure 2-50) was selected and sampled in 2001 to document the abundance of the wild trout population present. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-32.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the upper Laurel Fork station in 2001 are given in Table 2-33. Upper Laurel Fork's low-gradient (<2%) channel is relatively entrenched and bank erosion is still occurring. Consequently, sedimentation, along with a general lack of instream cover, contributed to a suboptimal habitat quality rating (Table 2-33). Yet despite its small size and relatively poor habitat, this portion of Laurel Fork still supports an above average total wild trout standing crop (41 kg/ha). Although a few large fish can bias standing crop estimates in small streams such as this, only four individuals in the 203- and 229-mm size classes were captured (Figure 2-51). Above-average fertility, as indicated by its pH (7.1) and alkalinity (30 mg/L), may provide a measure of compensation for the suboptimal habitat conditions.

Management Recommendations

Precisely when and how wild trout became re-established in upper Laurel Fork remains unknown, but it is likely that brook trout never disappeared entirely and brown trout probably colonized this area from the excellent population downstream. In any case, habitat conditions have apparently improved and the viable wild trout populations now present should be maintained. Upper Laurel Fork is currently subject to a three-fish creel limit, a 229-mm minimum size limit (154 mm for brook trout), and the use of artificial lures only, although its small size and limited access probably restrict its value as a fishery to local importance.

Upper Laurel Fork Sampling Station

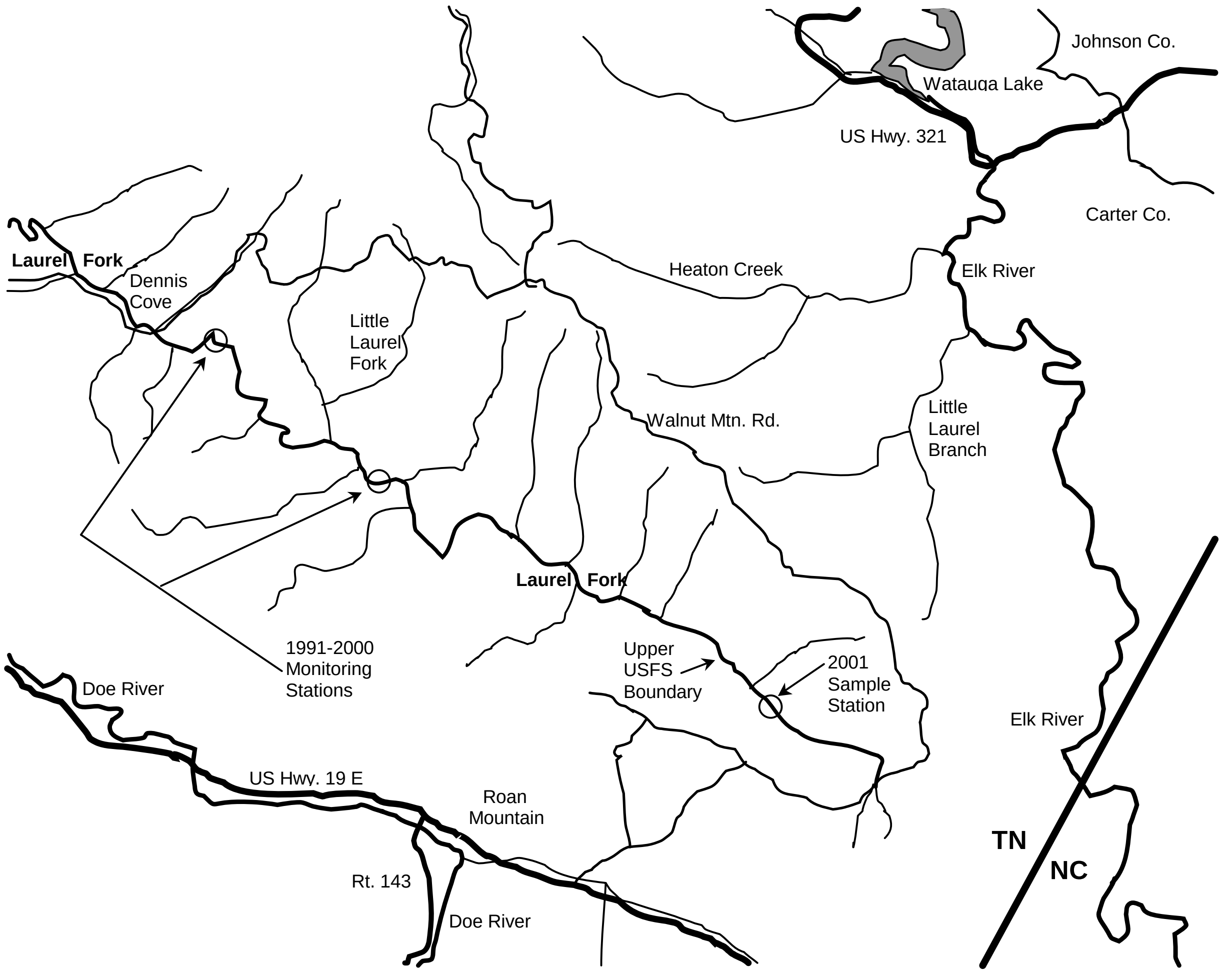


Figure 2-50. Location of the 2001 sampling station on upper Laurel Fork.

Table 2-32. Site and sampling information for upper Laurel Fork in 2001.

Location	**Station 1**
Site Code	420011201
Sample Date	24 July
Watershed	Watauga River
County	Carter
Quadrangle	White Rocks Mtn. 208 NE
Lat-Long	361249N-820120W
Reach Number	06010103-17,0
Elevation (ft)	3,320
Stream Order	2
Land Ownership	Private
Fishing Access	Poor
Description	Site began ~250 m upstream of ford that crosses Laurel Fork to an old two story farmhouse on a Christmas tree plantation.

Effort	
Station Length (m)	79
Sample Area (m^2)	162
Personnel	2
Electrofishing Units	1
Voltage (AC)	350
Removal Passes	3

Habitat	
Mean width (m)	2.1
Maximum depth (cm)	55
Canopy cover (%)	5
Aquatic vegetation	scarce
Estimated % of site in pools	42
Estimated % of site in riffles	58
Visual Hab. Assess. Score	123 (suboptimal)

Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	15	5
Sand	35	45
Gravel	50	50
Rubble		
Boulder		
Bedrock		

Water Quality	
Flow (cfs)	normal
Temperature (C)	16.8
pH	7.1
Conductivity (uS/cm)	67
Dissolved Oxygen (mg/L)	--
Alkalinity (mg/L $CaCO_3$)	30

Table 2-33. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on upper Laurel Fork sampled 24 July 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
BKT <90 mm	9	9	9	10	19	2.1	1.14	1.14	1.27	542	542	602
BNT >90 mm	11	11	11	11	667	60.6	40.18	40.18	40.18	663	663	663
Blacknose dace	14	14	14	16	78	5.6	4.70	4.70	5.40	843	843	964
Creek chub	2	2	2	2	7	3.5	0.42	0.42	0.42	120	120	120
Totals	**36**	**36**	**36**	**39**	**771**		**46.44**	**46.44**	**47.27**	**2,168**	**2,168**	**2,349**

Note: BKT = brook trout; BNT = brown trout.

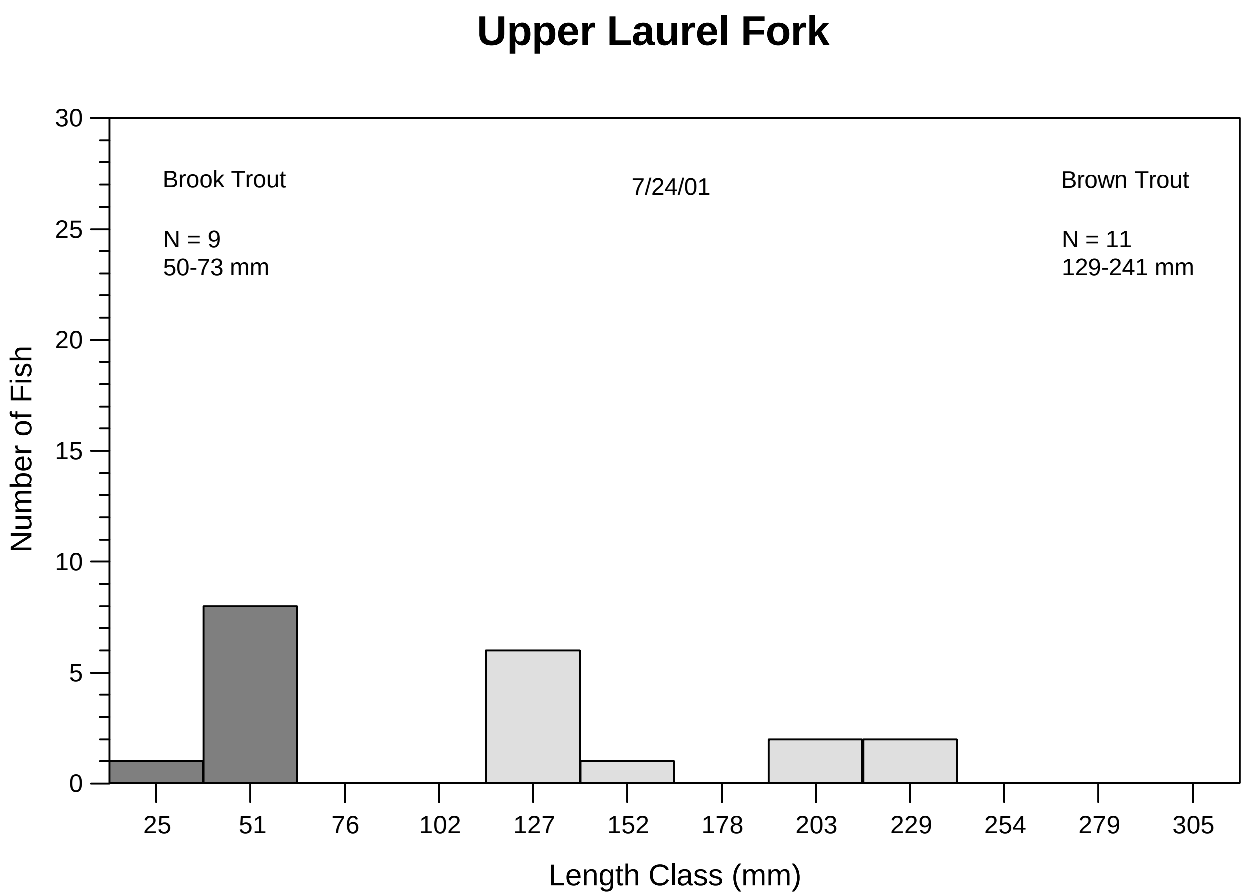


Figure 2-51. Length frequency distributions for rainbow trout from the 2001 upper Laurel Fork sample. Length classes shown (mm) correspond to inch groups (1-12).

2.4.3 Roaring Creek

Study Area

Roaring Creek is a tributary to Forge Creek and Roan Creek in Johnson County. It flows from the southwestern side of Pine Mountain near Baldwin Gap and is located entirely on private land. The watershed is mountainous and forested, with a substantial amount of agricultural and residential land use. Shields (1950) does not specifically mention Roaring Creek in his review of Johnson County trout streams, but does state that Roan Creek and Forge Creek should be removed from TWRA's stocking list because of elevated water temperatures and siltation associated with road construction and farming. Tatum (1968) listed Payne Hollow Branch (a Forge Creek tributary) as having brook trout, but mentioned no other streams in the Forge Creek drainage. Forge Creek and upper Roan Creek are currently on TWRA's annual spring trout stocking list and general, statewide trout angling regulations apply to these streams, as well as Roaring Creek.

A site was located about 365 m upstream of the confluence with Forge Creek (Figure 2-52) and quantitatively sampled in 2001 to document the presence and abundance of wild trout in Roaring Creek. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-34.

Results and Discussion

Catch data and abundance estimates for trout and other species sampled at the Roaring Creek station in 2001 are given in Table 2-35. Only 15 rainbow trout were captured, but standing crop (26 kg/ha) was about average for Tennessee trout streams. However, the trout population size structure was not well balanced (Figure 2-53). No YOY were collected and all fish were 163-209 mm in length. The size uniformity of the trout present, lack of YOY, and water temperature (20.7 C in mid-June) suggest that this might not be a wild population, but there are no recent records of any trout being stocked by TWRA in Roaring Creek. Forge Creek has been stocked about four times each spring since 1993, but only with catchable-sized rainbows (245-330 mm). If the trout collected in Roaring Creek were not wild fish, then they must have been stocked as fingerlings based on their size and appearance. Other potential sources for trout inhabiting lower Roaring Creek are upstream tributaries. Wild rainbow trout, including numerous YOY, were captured in a 1999 qualitative survey of Fall Branch near its confluence with Stout Branch (where Roaring Creek is formed).

Management Recommendations

It remains questionable whether or not Roaring Creek (particularly the lower portion of the stream) currently supports a wild trout population. If so, reproduction and recruitment may be extremely limited or dependent upon fish produced in upstream tributaries. In any case, Roaring Creek probably can support a trout fishery most of the year. The existing fishery could probably be improved with occasional stocking of fingerlings or catchable trout. General trout angling regulations currently apply to the stream and no changes are necessary.

Roaring Creek Sampling Station

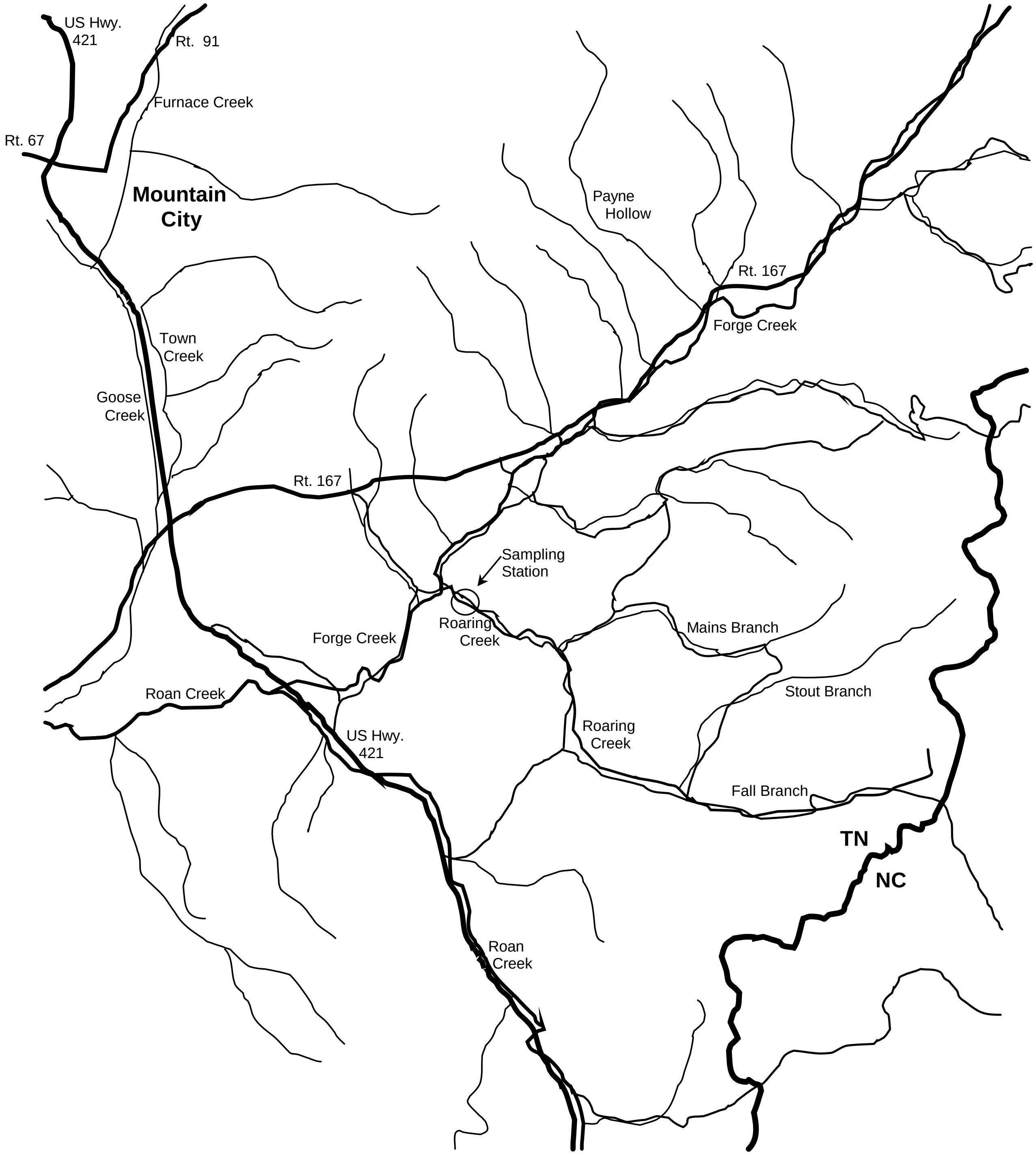


Figure 2-52. Location of the 2001 sampling station on Roaring Creek.

Table 2-34. Site and sampling information for Roaring Creek in 2001.

Location	**Station 1**	
Site Code	420010901	
Sample Date	21 June	
Watershed	Watauga River	
County	Johnson	
Quadrangle	Mountian City 214 NE	
Lat-Long	362621N-814601W	
Reach Number	06010103	
Elevation (ft)	2,460	
Stream Order	3	
Land Ownership	Private	
Fishing Access	Limited	
Description	Site began ~15 m upstream of the second road crossing (upstream of confluence with Forge Creek). It ended in a large pool at cascade where a small trib. enters from LBD.	
Effort		
Station Length (m)	114	
Sample Area (m²)	399	
Personnel	2	
Electrofishing Units	1	
Voltage (AC)	250	
Removal Passes	2	
Habitat		
Mean width (m)	3.5	
Maximum depth (cm)	91	
Canopy cover (%)	60	
Aquatic vegetation	scarce	
Estimated % of site in pools	42	
Estimated % of site in riffles	58	
Visual Hab. Assess. Score	144 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	15	10
Sand	10	15
Gravel	20	30
Rubble	20	30
Boulder	20	15
Bedrock	15	
Water Quality		
Flow (cfs; visual)	normal	
Temperature (C)	20.7	
pH	7.6	
Conductivity (uS/cm)	87	
Dissolved Oxygen (mg/L)	--	
Alkalinity (mg/L $CaCO_3$)	50	

Table 2-35. Estimated fish population sizes, standing crops, and densities (with 95% confidence limits) for one station on Roaring Creek sampled 21 June 2001.

		Population Size			Est.	Mean	Standing Crop (kg/ha)			Density (Fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Biomass (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
RBT >90 mm	15	15	15	15	1,050	70.0	26.32	26.32	26.32	376	376	376
Blacknose dace	49	52	49	59	233	4.5	5.84	5.53	6.65	1,303	1,228	1,479
Creek chub	42	44	42	49	732	16.6	18.35	17.47	20.39	1,103	1,053	1,228
Stoneroller	7	7	7	7	99	14.1	2.48	2.48	2.47	175	175	175
Totals	**113**	**118**	**113**	**130**	**2,114**		**52.99**	**51.80**	**55.83**	**2,957**	**2,832**	**3,258**

Note: RBT = rainbow trout.

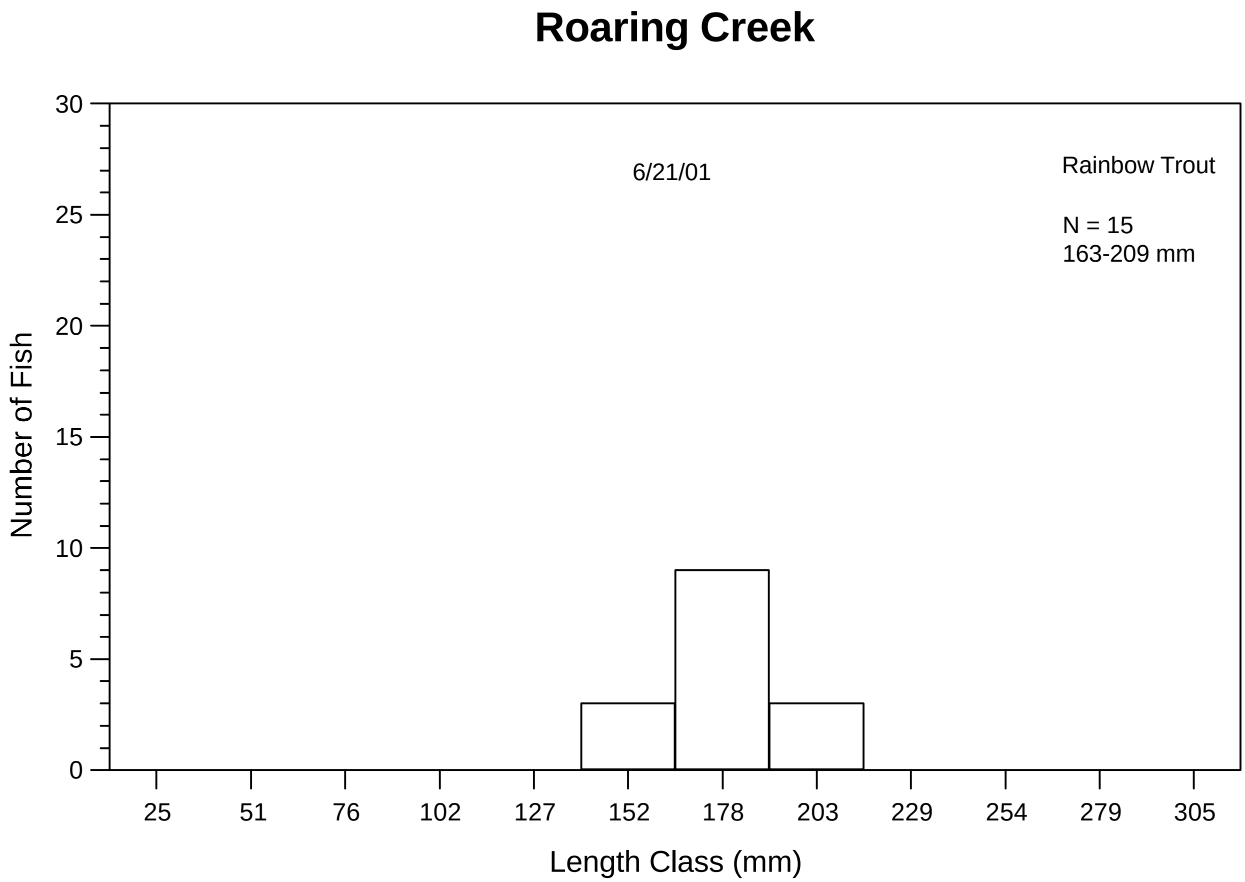


Figure 2-53. Length frequency distributions for rainbow trout from the 2001 Roaring Creek sample. Length classes shown (mm) correspond to inch groups (1-12).

2.5 DISEASE SCREENING

The U.S. Fish and Wildlife Service (USFWS) initiated a National Wild Fish Health Survey in 1997 in order to meet the congressional mandate of establishing and maintaining a National Fish Disease Database. The purpose of this national survey is to "determine the distribution of certain pathogens in fish in the wild" (USFWS 1997). The development of this extensive survey has been dependent upon establishing partnerships between federal and state agencies that manage wild fish population throughout the country (USFWS 1997).

The Warm Springs Regional Fisheries Center contacted TWRA in 1997 as a potential cooperator in the program. After reviewing the objectives of the investigation and the procedures involved in collecting samples, the decision was made to begin testing Tennessee's wild trout populations that are subject to stockings of hatchery-reared fish. Since 1997, rainbow and brown trout from Tellico River, Bald River, North River, North Indian Creek (Unicoi Co.), Stony Creek (Carter Co.), Doe River (Carter Co.), Doe Creek, Laurel Creek, and Beaverdam Creek have been analyzed. These fish were evaluated for Infectious Pancreatic Necrosis Virus (IPN), Infectious Hematopoietic Necrosis Virus (IHN), Viral Hemorrhagic Septicemia Virus (VHS), *Oncorhynchus masou* Virus (OMV), *Renibacterium salmoninarum* (RS), *Aeromonas salmonicida* (AS), *Yersinia ruckeri* (YR), and *Myxobolis cerebralis* (whirling disease, WD).

No trout for disease screening were collected in 2001. The results of tests on previous samples have been negative for most pathogens. Most samples have tested positive for RS, but no clinical signs of disease were present. All whirling disease tests completed to date have been negative. The lack of disease problems in Tennessee's wild trout populations is relatively unsurprising; however, Rocky Fork and Laurel Fork will also be sampled in 2002.

2.6 OVERVIEW

2.6.1 Abundance and Population Structure

Summary statistics for wild trout populations at 167 different quantitative sample sites during 1991-2000 (Habera et al. 2001a) are provided below. Average density and standing crop for these samples were 1,392 fish/ha and 31.41 kg/ha, respectively. Fewer than 10% of trout density or standing crop estimates exceeded 3,200 fish/ha or 70 kg/ha (Habera et al. 2001a).

	Sites[1] (N)	**Lower 95% conf. limit**	**Mean**	**Upper 95% conf. limit**	**Median**	**Range**
Density (n/ha)	167	1,224	1,392	1,560	1,062	52-6,067
Standing Crop (kg/ha)	167	27.47	31.41	35.34	25.14	2.01-192.21

[1]Means were used for all sites that have been sampled more than once (monitoring stations).

Individual density and standing crop statistics for rainbow, brook, and brown trout (during 1991-2000) are also provided below. Brown trout tend to occur at lower densities (mean, 245/ha) than either brook (mean, 1,220/ha) or rainbow trout (mean, 1,259/ha). However, because of their larger average size, mean standing crop for brown trout (19.27 kg/ha) was more similar to the means for brook and rainbow (21.37 and 28.91 kg/ha, respectively) and the confidence intervals for all three species overlap extensively. Brook trout abundance was similar to that reported by Moore and Kulp (1995) for 16 GSMNP streams where no harvest is permitted (mean density, 1,022/ha; mean standing crop, 16.96 kg/ha).

	Sites[1] (N)	**Lower 95% conf. limit**	**Mean**	**Upper 95% conf. limit**	**Median**	**Range**
			Rainbow Trout[2]			
Density (n/ha)	113	1,036	1,259	1,482	886	23-6,067
Standing Crop (kg/ha)	113	23.84	28.91	33.97	19.66	1.48-179.72
			Brook Trout[2]			
Density (n/ha)	70	1,004	1,220	1,437	993	113-5,428
Standing Crop (kg/ha)	70	17.51	21.37	25.23	16.73	3.96-93.77
			Brown Trout[2]			
Density (n/ha)	28	147	245	342	209	9-1,163
Standing Crop (kg/ha)	28	10.95	19.27	27.60	14.20	0.83-100.41

[1]Means were used for all sites that have been sampled more than once (monitoring stations).
[2]Samples from sympatric populations were excluded if they represented <5% of total standing crop (usually one fish).

Rainbow trout up to 361 mm were captured in quantitative samples during 1991-2000, but only about 14% of all rainbow trout have been 178 mm (7 in.) or larger and just over 2% have been 229 mm (9 in.) or larger (Habera et al. 2001a). Overall, 70% of rainbow trout biomass was distributed among the 127-mm through 203-mm (5-in. through 8-in.) length groups. Brown trout up to 635 mm have been captured and, in contrast to rainbow trout populations, almost one third of all brown trout (31%) have been ?178 mm and about 15% were ?229 mm (64% of total biomass was ?229 mm). About 14% of all brook trout in quantitative samples have exceeded the minimum size limit of 152 mm (6 in.), <1% of all brook trout were ?229 mm, and none were >301 mm, although a few brook trout in the 305-mm (12-in.) size class have been collected in qualitative samples (Habera et al. 2001a).

Annual rainfall in the Tennessee River valley above Chattanooga averages 127 cm (50 in.), but there was a deficit of 76 cm (30 in) during July of 1998 through February 2001, causing stream flows to fall to 60% of their normal levels (B. Arnwine, TVA, personal communication). Rainfall was closer to average for 2001, but there was still about a 20-cm (8-in.) deficit (B. Arnwine, TVA, personal communication). Declining trends in wild trout abundance at several long-term monitoring stations over the past four years appear to illustrate the effects of the reduced flows and temperature increases that have also likely occurred. Additional impacts will depend upon the duration of the dry conditions, but unless they continue for several more years, wild trout abundances should recover relatively quickly as they did following the severe, region-wide flooding that occurred in 1994 and drastically reduced abundances.

Notwithstanding current trends, average wild trout abundance in Tennessee streams is typical of populations elsewhere in the southern Appalachian (Habera and Strange 1993; Durniak et al. 1997). However, Platts and McHenry (1988) found average trout and charr abundance in 313 streams of the interior western U.S. to be about twice as high, and Kwak and Waters (1997) reported a mean salmonid biomass (primarily brown trout) of 162 kg/ha for 13 southeastern Minnesota streams. A few of Tennessee's wild trout populations have attained abundances of 100 kg/ha, but standing crops several times this amount have been estimated for some Western streams (Platts and McHenry 1988; Behnke 1992) and some spring-fed streams in the limestone areas of Pennsylvania (Behnke 1992). Waters (1992) suggested that production ranging from 100-300 kg/ha defined the upper echelon of stream trout fisheries.

The relatively low abundances and small size of wild trout supported by southern Appalachian streams are related to the extremely soft (<25 mg/l as $CaCO_3$), infertile waters that characterize most of the region. Food resources are limited (King 1942), particularly during the summer months when trout metabolic rates are highest (Cada et al. 1987; Ensign et al. 1990). Where alkalinity is higher (e.g., >40 mg/L in Tennessee, Strange and Habera 1998a), wild trout abundance also increases. Kwak and Waters (1997) found a significant positive correlation between salmonid production and alkalinity for streams throughout the United States. Supplemental feeding studies (England 1978; Strange and Habera 1994; Borawa et al. 1995) provide further evidence that wild trout populations are primarily food-limited.

Habitat (including cover) can function as a control on the utilization and partitioning of available food resources for stream salmonids (Wilzbach et al.1986; Cada et al. 1987). The importance of cover relative to trout growth and abundance declines in food-limited streams (Wilzbach 1985; Wilzbach et al.1986), but one type--large woody debris (LWD)--has several beneficial effects on salmonid abundance (House and Boehne 1986; Flebbe and Dolloff 1995). Durniak et al. (1997) found a positive relationship between LWD and the density of brook and brown trout in Georgia streams. Streams flowing through old-growth forests have a greater abundance of LWD than streams in younger, second growth forests (Silsbee and Larson 1983; Flebbe and Dolloff 1995). Because most of Tennessee's wild trout streams flow through second-growth forests, sporadic LWD (Strange and Habera 1992-1998a) may also limit trout abundance to some degree. A recent TWRA\USFS study (Carter and Carter in prep.) found no significant increases in brook or rainbow trout standing crop, or in the density of trout ?152 mm, following installation of 44 habitat improvement structures in three Tennessee streams.

2.6.2 Age, Growth, and Mortality

Scale samples from 4,118 rainbow trout (72 populations) and 1,418 brown trout (17 populations) have been examined (1991-1997) for the purpose of determining growth rates. Mean backcalculated lengths at age based on these analyses (Strange and Habera 1998a) are given below. Growth and longevity characteristics of Tennessee’s wild trout are generally similar to those for populations elsewhere in the region (Mohn and Bugas 1980; Coulston and Maughan 1981; Durniak and England 1986; Durniak 1989; Kulp 1994; Moore and Kulp 1995). Additional work with otoliths and known-age fish will be necessary to validate growth rates based on scale analyses.

Backcalculated mean length at age (mm)							
Age	1	2	3	4	5	6	7
Rainbow	101	162	201	263	294	--	--
Brown	112	199	267	338	408	508	572

Mean lengths at capture (summer/fall) for rainbow trout (N=15,273) and brown trout (N=2,460) during the same period (1991-1997, Strange and Habera 1998a) were:

Mean length at capture (mm)								
Age	0	1	2	3	4	5	6	7
Rainbow	83	152	193	223	285	308	--	--
Brown	97	182	237	298	353	410	524	593

Weight-length relationships for Tennessee wild trout, based on geometric mean functional regressions (as advised by Ricker 1975), were also calculated for fish collected during 1991-1999 (rainbows through 1998):

	N	Range (mm)	r^2	Equation
Rainbow	16,384	50-361	0.985	log w = -4.856 + 2.924 (log l)
Brown	3,942	52-647	0.993	log w = -4.994 + 2.992 (log l)
Brook	3,771	50-301	0.982	log w = -5.123 + 3.053 (log l)

Total annual mortality for rainbow trout was estimated to be 68% (Strange and Habera 1998a), and is comparable to that for other wild populations in the southern Appalachians (Durniak and England 1986; GSMNP 1994; Moore and Kulp 1995). Only about 2% of all rainbow trout sampled were ?age 3, and mean length at capture data indicate that the average fish does not reach 229 mm (~9 in.) until about age 3. Therefore, many fish that reach 229 mm are faster growing age-2 (and some age-1) individuals. Age and growth data based on otoliths are now being collected for rainbow trout and will be compared with scale-derived data. Hining et al. (2000) identified wild rainbows up to age 5 while validating scale and otolith ages of oxytetracycline-marked fish from two southern Appalachian streams and concluded that scales may provide unreliable age estimates for fish beyond age 2.

Total annual mortality for brown trout was estimated to be about 50% (Strange and Habera 1998a), which is at the lower end of the ranges reported in the literature (50-95%, Carlander 1969; 58-65%, Craig 1982; 75-78%, Cataloochee Creek, Moore and Kulp 1995). Compared with rainbow trout, a much larger percentage of brown trout (~8%) survive to age 3 and beyond. On average, brown trout exceeded 229 mm (9 in.) at age 2 and might be better suited to a 229-mm minimum size limit than rainbow trout. Preliminary analyses of otoliths (including those from known-age fish) from 11 streams indicated the presence of 12 age classes. Scale-derived ages were generally reliable through about age 4, but tended to underestimate otolith age for older fish (with discrepancies of up to five years). Both brown and rainbow trout mortality rates may be somewhat inaccurate because scale-derived ages were used in their calculation.

2.6.3 Angling Regulations

Angler harvest of wild trout is an acceptable substitute for natural mortality provided that reproductive capacity (Durniak and England 1986) and population structure remain intact. Documented exploitation rates for wild rainbow trout (5-15% for Little River, Masterson 1991 and M. Kulp, GSMNP, personal communication; 5% for North River and 12% for Tellico River, Bates 1997), brook trout (39% for six streams, England 1979) and brown trout (22% for Chattooga River, Durniak 1989) have not proven damaging to reproductive capacity. Therefore, restrictive regulations directed at protecting or enhancing spawning stocks have been judged ineffective (England 1979) or unnecessary (Durniak 1989).

Fish in 127-203-mm (5-8-in.) size classes dominate the adult segment of Tennessee's wild rainbow trout populations, as is true of populations elsewhere in the southern Appalachians (Seehorn 1985). Harvest of these fish is biologically justifiable and is permitted in most wild rainbow trout populations in the Tennessee. However, a 229-mm minimum size limit applies to rainbow trout harvest in 10 streams and their tributaries. This compels anglers who desire to harvest fish to selectively remove them from the smallest segment of those populations. Seehorn (1985) noted that this type of selective harvest might actually cause a reduction in the abundance of trout larger than the size limit, and such reductions have been observed for other species (e.g., Dunning et al. 1982).

If angling pressure (and harvest) became great enough (e.g., in North River), a 229-mm minimum size limit could help maintain catch rates through the recycling of fish. However, where exploitation is a small part of total mortality (as it probably is in most of Tennessee’s wild trout populations), minimum size limits are of little value (Noble and Jones 1993). In cases where a minimum size limit is deemed sociologically or politically necessary, the most appropriate one for wild rainbow trout in Tennessee would be about 178 mm (7 in). This would transfer some harvest pressure to the population segment with the largest biomass (Habera et al. 2001a). It might also improve growth rates for some fish by reducing competition among cohort members. The Virginia Department of Game and Inland Fisheries, North Carolina Wildlife Resources Commission, and National Park Service (GSMNP) currently use a 178-mm minimum size limit to manage wild trout streams under their respective jurisdictions.

Restrictive creel and size limits might have a better chance of producing desirable biological results for wild brown trout because of their potential for longer life spans and larger size, but their susceptibility to angling is notoriously low (Behnke 1990; Heidinger 1993). Because it would be difficult for anglers to induce mortality in excess of natural mortality, restrictive regulations currently have little potential to produce effects such as increased abundance or population structure shifts in Tennessee streams.

3. TAILWATER ACCOUNTS

Hill (1978) recognized that tailwater trout fisheries in the Tennessee Valley present unique fishery management problems and opportunities for which no standard solutions or practices apply. The difficulties inherent in sampling tailwaters (i.e., large waters, fluctuating flows, the inability to maintain a closed population, etc.) make it difficult at best to collect quantitative data from these systems. Most tailwater trout populations are also largely "artificial", with abundance and age-class densities dependent upon stocking rates and, typically, little or no significant natural reproduction. Annual tailwater sampling in Region IV began in 1991 (Bivens et al. 1992), but the initial efforts provided only basic information such as species composition, catch per unit effort (CPUE) estimates, and size distributions from a few stations. Because TWRA did not have the information necessary to manage the increasingly popular trout fisheries in the Clinch, South Fork Holston, and Watauga river tailwaters, more intensive studies focusing on assessment of trout abundance, the fate of stocked fish, and angler use have recently been completed (Bettoli and Bohm 1997; Bettoli et al. 1999; Bettoli 1999; Bettinger and Bettoli 2000). The Ft. Patrick Henry tailwater (South Fork Holston River) was sampled in 2000 (Habera et al. 2001a), but additional information will be needed to manage this trout fishery, as well as the one developing in the Cherokee tailwater (Holston River).

3.1 SAMPLING METHODS

The electrofishing stations and sampling protocols for the Norris, South Holston, and Wilbur tailwaters in 2001 were those established by Bettoli and Bohm (1997), Bettoli et al. (1999), and Bettoli (1999). Sampling effort consisted of a 10-min (pedal time) run at each station with a boat-mounted electrofishing system (120 pulses/s DC, 4-5 amps). All electrofishing on these tailwaters occurred during periods of generation by one unit (turbine). The Norris tailwater was sampled at night at a flow of ~114 m^3/s (4,000 CFS or one unit). The South Holston and Wilbur tailwaters were sampled during the day at flows of ~71 m^3/s (2,500 CFS) because of safety considerations. Only trout were collected during these efforts.

3.2 ANNUALLY-MONITORED TAILWATERS

TWRA began sampling the Norris and South Holston tailwaters in 1999 (Habera et al. 2000) and the Wilbur tailwater in 2000 (Habera et al. 2001a). These three tailwaters will be monitored at the 12 established stations each year in February and early March to provide an assessment of the overwintering trout populations present before stocking begins.

3.2.1 Norris (Clinch River)

Study Area

The Clinch River arises in southwestern Virginia and enters Tennessee in Hancock County. Norris Dam impounds the Clinch River 197 km (122 mi) downstream in Anderson

County, forming 13,846-ha (34,213-acre) Norris Reservoir. Hypolimnetic discharges created coldwater habitat and rainbow trout were stocked in the tailwater shortly after completion of the dam in 1936 (Tarzwell 1939). The Tennessee Game and Fish Commission stocked trout during 1950-1970 and managed the river as a year-round fishery (Swink 1983). Because chronic low dissolved oxygen levels and a lack of minimum flow limited development of the trout fishery (Boles 1980; Yeager et al.1987), TVA began a Reservoir Release Improvements Program (TVA 1980) to address these problems. Dissolved oxygen concentrations were improved initially by fitting the turbines with a hub baffle system (Yeager et al. 1987). Later (1995 and 1996), both turbines were replaced with a more efficient autoventing system (Scott et al. 1996), which maintains dissolved oxygen around 6 mg/L. A minimum flow of 5.7 m^3/s (200 CFS) was established in 1984 and has been maintained since then by a re-regulation weir located about 3.2 km (2 mi) downstream of the dam (Yeager et al. 1987). The weir was upgraded in 1995 to increase its holding capacity and improve public access (Bettoli and Bohm 1997).

Improvements in dissolved oxygen and minimum flows have increased the abundance and distribution of benthic invertebrates, as well as trout carrying capacity and trout condition (Yeager et al. 1987; Scott et al. 1996). The Norris tailwater currently supports a 20-km (12.5-mi) fishery for rainbow and brown trout before entering Melton Hill Reservoir. Put-and-take and put-grow-and-take management is accomplished by annually stocking both fingerling and adult trout. Bettoli and Bohm (1997) documented a small amount of natural reproduction by rainbow trout, but recruitment to the tailwater fishery was considered to be minimal. Some of this natural reproduction may come from Clear Creek, which large rainbow trout enter to spawn each winter. Clear Creek is closed to fishing from December 1 through March 31 to protect these fish. Banks and Bettoli (2000) attributed the lack of brown trout reproduction in the Norris tailwater to poor spawning substrate and unsuitable flows during spawning season. These factors probably limit successful rainbow trout reproduction as well.

As the trout fishery in the Norris tailwater has improved through better water quality and flow, it has gained increased popularity among trout anglers, including those seeking large fish. The current state-record brown trout, weighing 13.04 kg (28.75 lb), was caught in the tailwater in 1988. In response to pressure from a stakeholder group in 1992, the Tennessee Wildlife Resources Commission established a 6.6- km (4.1-mi) “quality zone” between Cane Creek and the mouth of Llewellyn Island. Regulations in the quality zone prohibited the use of natural bait and included a 2-fish creel limit and a 356-mm (14-inch) minimum size limit (Bivens et al. 1995). Another stakeholder group was dissatisfied with this change and the controversy led to a modification of the quality zone regulations in 1993. Later, the quality zone and its special regulations were eliminated; statewide trout angling regulations (7-fish creel limit, no bait or size restrictions) currently apply to the entire tailwater.

Aside from a few cursory surveys, trout population data for the Norris tailwater prior to 1995 is limited. TWRA sampled two stations in 1993 and 1994 (following establishment of the quality zone) using boat and backpack electrofishing gear during low flow (Bivens et al. 1994, 1995). The first intensive study of the Norris tailwater trout fishery was conducted between 1995 and 1997 (Bettoli and Bohm 1997). Results of that investigation indicated that the river supported an overwinter standing crop of 112 kg/ha composed of about 80% rainbow trout and 20% brown trout. Among other Tennessee tailwaters, only South Holston and Wilbur had higher trout biomass estimates at that time (Bettoli 1999). Bettoli and Bohm (1997) reported a relatively low return rate for stocked rainbow trout (19%) and very few brown trout were observed in the creel. The abundance of most cohorts of catchable (208-330 mm) rainbow trout stocked in the tailwater was found to be limited more by natural mortality than by angler harvest, thus the fishery is primarily supported by fingerling rainbow trout stocking (Bettoli and Bohm 1997; Bettinger and Bettoli 2000). High growth rates of stocked trout (about 20 mm/month for rainbows), allow the tailwater to produce quality-sized trout within a relatively short time (Bettoli and Bohm 1997).

The locations of TWRA's 12 monitoring station on the Norris tailwater are provided in Figure 3-1 and additional sample location and effort details are summarized in Table 3-1.

Results and Discussion

The 12 Norris tailwater stations produced 373 trout weighing 111.84 kg in 2001 (Table 3-2). The catch included 317 rainbows (85%) and 56 browns (15%). Rainbow trout ranged from 134-600 mm, browns ranged from 177-652 mm, and most fish were in the 203-305 mm size range (Figure 3-2). Trout ?356 mm ("quality-size" fish) made up 11% of the catch, while about 4% were ?457 mm and about 3% were ?508 mm. The overall 2001 CPUE estimate for all trout was 182.6 fish/h (range, 72.0-301.8 fish/h; Table 3-2) and the catch rate for trout ?178 mm (considered fully recruited to the sampling gear) was the highest since monitoring by TWRA began (see below). The 2001 catch rates also exceeded those for 1996 (Bettoli and Bohm 1997) and November 1994 (69 fish/h, Bivens et al. 1995).

	CPUE (fish/h) ?178 mm		
Year	**Rainbow trout**	**Brown trout**	**Total**
1996[1]	68.5	14.5	83.0
1999	10.5	70.0	80.5
2000	81.2	56.7	137.9
2001	148.4	27.2	175.6
Mean	77.2	42.1	119.3

[1]Data are from Bettoli and Bohm (1997) and represent the same 12 stations sampled during 1999-2001.

Rainbow trout dominated the catch in the 1994 (88%) and 1996 (83%) samples, but brown trout were more abundant in 1999 (72%). Subsequently, rainbow trout catch rates have increased and the relative abundance brown trout has dropped to 15%. Even though total brown trout catch rates and relative abundances have decreased since 1999, catch rates for larger trout (?356 mm, ?457 mm, and ?508 mm) have generally increased. Electrofishing catch rates for trout ?356 mm exceeded 20 fish/h the last two years (see below). Most of these were rainbow trout in 2001 and included three fish >508 mm (20 inches). Bettoli and Bohm (1997) reported no rainbows in this size range (?508 mm) and prior to 2001 none were captured during TWRA's annual monitoring. However, browns still dominate the catch of trout ?457 mm (18 inches). TWRA's 1994 samples (Bivens et al. 1995) produced catch rates for trout ?356 mm, ?457 mm, and ?508 mm of 21.3 fish/hr, 3.0 fish/hr, and 2.0 fish/hr, respectively. These catch rates were relatively similar to the 1996-2001 means for each size group.

	CPUE (fish/h) ?356 mm		
Year	**Rainbow trout**	**Brown trout**	**Total**
1996[1]	6.5	3.0	9.5
1999	2.0	6.9	8.9
2000	7.4	17.8	25.2
2001	12.9	7.4	20.3
Mean	7.2	8.8	16.0
	CPUE (fish/h) ?457 mm		
1996[1]	0.0	0.5	0.5
1999	0.0	1.0	1.0
2000	0.5	7.4	7.9
2001	2.5	4.5	7.0
Mean	0.8	3.4	4.1
	CPUE (fish/h) ?508 mm		
1996[1]	0.0	0.5	0.5
1999	0.0	1.0	1.0
2000	0.0	3.5	3.5
2001	1.5	4.0	5.5
Mean	0.4	2.3	2.6

[1]Data are from Bettoli and Bohm (1997) and represent the same 12 stations sampled during 1999-2001.

The Norris tailwater was stocked with 271,313 trout during calendar year 2001, which is comparable to previous rates. Of this total, 77,964 were brown trout (including about 60,000 fingerlings). Both fingerling (averaging about 127 mm) and catchable (averaging about 305 mm) rainbows were stocked at rates of 160,049 and 33,300, respectively. The stocking history for the Norris tailwater since 1990 is provided below and on average, about a quarter of a million (251,000) 102-330 mm (4-13 inch) trout were released each year during 1990-2001.

Year	Rainbow Trout	Brown Trout	Total
1990	303,294	26,024	329,318
1991	230,656	17,932	248,588
1992	203,687	20,005	223,692
1993	264,728	--	264,728
1994	187,935	10,004	197,939
1995	197,756	17,539	215,295
1996	122,208	13,937	136,145
1997	217,367	125,501	342,868
1998	198,894	111,362	310,256
1999	199,042	20,000	219,042
2000	242,257	10,453	252,710
2001	193,349	77,964	271,313
Mean	213,431	40,975	250,991

Fingerlings (102-152 mm fish) made up 80-85% of the rainbow trout stocked each year except in 1996 (74%). On average, 176,000 fingerling rainbows were released in the Norris tailwater each year during 1990-2001, which is a stocking density of 701/ha (284/acre). The rest of the rainbows stocked in the Norris tailwater (averaging about 37,000/year) were catchables. Survival of these catchable rainbow trout is poor and few contribute to the fishery. Most die (possibly from energetic costs of excessive movement) or emigrate into Melton Hill Reservoir (Bettoli and Bohm 1997; Bettinger and Bettoli 2000). Bettoli (2000) considered the potential for striped bass *Morone saxatilis* predation on stocked trout to be inconsequential because the striper population (in Melton Hill Reservoir) is small and few ever move upstream of the shoals near the Highway 61 Bridge. Despite the importance of rainbow trout fingerlings to the trout fishery in the Norris tailwater, there are no data to indicate what stocking density is ideal. Therefore, the current rate may not be maximizing the tailwater's potential.

Most brown trout stocked in the tailwater during 1990-2001 have been 178-229 mm fish, although all of the browns stocked in 1990 and 1996, and most of those stocked in 2001 were fingerlings. The brown trout stocking rate was increased substantially in 1997 and 1998 and included about 100,000 fingerlings each year. Recruitment from these stockings most likely led to the high brown trout catch rate and relative abundance in 1999, as well as the increases in catch rates for larger trout in 2000. With the return to more regular brown trout stocking rates during 1999-2000 (~15,000/year), brown trout catch rates declined and rainbow trout again dominated the fishery. These results indicate that higher brown trout stocking rates could potentially help achieve management objectives that seek to increase overall trout abundance and the abundance of larger fish in the Norris tailwater.

Creel data from recent surveys on the Norris tailwater (provided below) indicate that angling pressure and harvest estimates appear to have stabilized recently. Current fishing pressure on the Norris tailwater is intermediate among other Tennessee tailwaters and is exceeded by pressure on the Watauga, Caney Fork, and South Fork Holston rivers (Bettoli 2002). The developing trout fishery in the nearby Cherokee tailwater (Holston River) is becoming increasingly popular and is probably now drawing a certain amount of angling pressure away from the Norris tailwater.

Catch rates for the Norris tailwater have generally declined since 1995, although catch rates over about 0.7 fish/h are considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993). Fraser (1995) concluded that the quality zone regulation was unsuccessful in producing significantly higher catch rates in 1993 and 1994. Anglers made an estimated 24,392 trips to the Norris tailwater during March-October 2001 (Bettoli 2002), which is statistically similar to pressure for a comparable interval in 1996-1997. However, average trout catch per hour and per trip in 2001 were significantly lower relative to the previous survey (Bettoli 2002). The proportion of completed trips for which no trout were harvested in 1996 (63%, Bettoli and Bohm 1997) increased to 79% in 2001 (Bettoli 2002). Over 80% of Norris tailwater anglers are residents of Knox, Anderson, and Campbell counties and over 70% fish with bait (Bettoli and Bohm 1997; Bettoli 2002).

Survey	**Estimated pressure (h)**	**Estimated harvest (trout)**	**Catch rate (trout/h)**
TVA (1973-1988 average)	66,023	29,899	0.43
Fraser (1995)	--	--	1.20
Bettoli and Bohm (1997)[1]	89,388	30,456	1.01
Bettoli (2002)[2]	87,081	25,739	0.62

[1]Data for April-October 1996 and March 1997.

[2]March-October 2001.

Management Recommendations

TWRA's management goal for the Norris tailwater is to enhance the quality of trout angling opportunities available to the variety of anglers who fish there. Improvements in water quality over the years have facilitated the development of an excellent trout fishery in this tailwater. Proper management can maintain the quality of this fishery and should provide for additional improvement. For example, the Norris tailwater might be capable of supporting a higher trout biomass or a higher abundance of quality-size fish (?356 mm). A management plan for the Norris tailwater trout fishery has been developed and will feature increased stocking densities for rainbow and brown trout fingerlings, along with several other actions intended to ultimately fulfill the management goal for this extremely valuable trout fishery:

1. Stock 36,000 catchable (9-13 inch) rainbow trout each year.

2. Stock 20,000 8-inch brown trout each spring, plus an additional 100,000 (minimum) brown trout fingerlings beginning in 2002. The additional fingerlings will be produced at TWRA's Eagle Bend hatchery on the Clinch River.

3. Stock 160,000 4-inch rainbow trout each spring, plus an additional 100,000 (minimum) rainbow trout fingerlings beginning in 2002. The additional fingerlings will be produced at Eagle Bend hatchery.

4. Annually determine (in February) population abundances and size structures for the tailwater trout fishery by electrofishing the 12 established monitoring stations and evaluate progress toward management plan objectives.

5. Genetically identify the large rainbow trout that are spawning in Clear Creek if possible and emphasize this strain in the stocking program (particularly fingerlings).

6. Enforce angling regulations as prioritized in the quarterly law enforcement planning process.

7. Increase angler access to the river if possible.

8. Continue to work with the Norris tailwater biomonitoring team.

9. Obtain input from anglers to determine their level of satisfaction with the quality and variety of trout angling opportunities being provided in the Norris tailwater (e.g., through the annual telephone surveys being conducted by the University of Tennessee Department of Forestry, Wildlife, and Fisheries).

10. Evaluate the feasibility of introducing other species into the Norris tailwater trout fishery (e.g., brook trout).

Most of these activities are already underway. If they do not result in achievement of the management plan objectives, then other options (e.g., those summarized by Bettoli 2001), will be considered.

Norris Tailwater

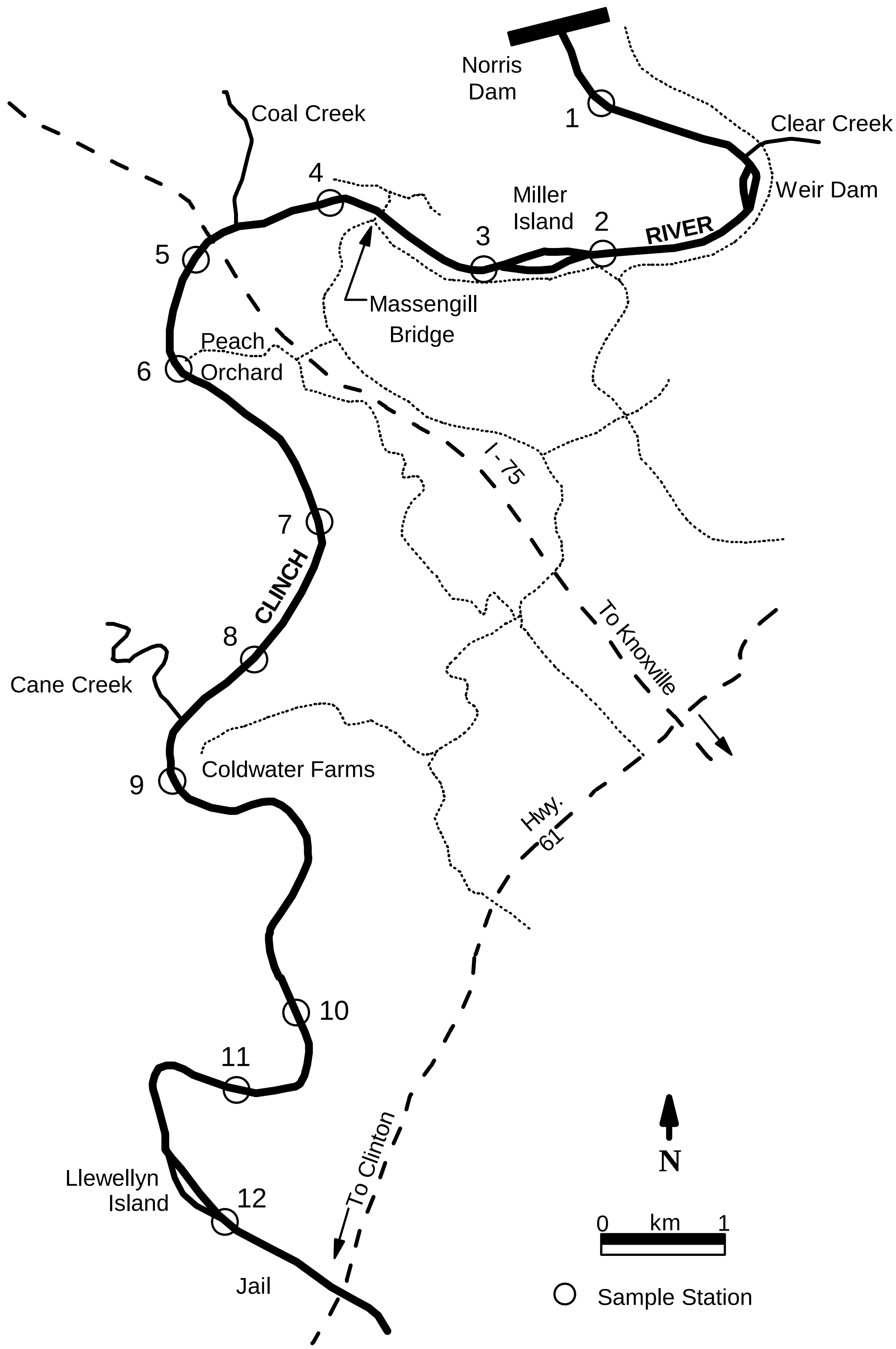


Figure 3-1. Locations of the 12 monitoring stations on the Norris tailwater (Clinch River).

Table 3-1. Location and sampling information for the 12 stations on the Norris tailwater, 1-2 March 2001.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420010101	Anderson	Norris 137 NE	361320N-840533W	06010207-19,1	79.7	603	75 V DC 120 PPS, 4 A
2	420010102	Anderson	Norris 137 NE	361217N-840515W	06010207-19,1	77.2	600	354 V DC 120 PPS, 5 A
3	420010103	Anderson	Norris 137 NE	361210N-840600W	06010207-19,1	76.3	690	200 V DC 120 PPS, 5 A
4	420010104	Anderson	Norris 137 NE	361227N-840640W	06010207-19,1	75.6	600	354 V DC 120 PPS, 5 A
5	420010105	Anderson	Lake City 137 NW	361220N-840730W	06010207-19,0	74.4	601	175 V DC 120 PPS, 5 A
6	420010106	Anderson	Lake City 137 NW	361150N-840740W	06010207-19,0	74.1	600	354 V DC 120 PPS, 5 A
7	420010107	Anderson	Norris 137 NE	361110N-840700W	06010207-19,0	73	601	150 V DC 120 PPS, 5 A
8	420010108	Anderson	Norris 137 NE	361030N-840705W	06010207-19,0	72.2	600	354 V DC 120 PPS, 5 A
9	420010109	Anderson	Norris 137 NE	360937N-840713W	06010207-19,0	70.4	602	150 V DC 120 PPS, 5 A
10	420010110	Anderson	Norris 137 NE	360855N-840710W	06010207-19,0	69.5	600	354 V DC 120 PPS, 5 A
11	420010111	Anderson	Norris 137 NE	360835N-840703W	06010207-19,0	69.1	602	200 V DC 120 PPS, 5 A
12	420010112	Anderson	Lake City 137 NW	360755N-840735W	06010207-19,0	67.2	600	354 V DC 120 PPS, 5 A

Table 3-2. Catch data for the12 electrofishing stations on the Norris tailwater (Clinch River) sampled 1-2 March 2001.

Site #	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)	CPUE (fish/h)
Station 1						
Rainbow trout	14	187-474	8,065	100	100	84.0
Brown trout	0			0	0	0.0
Totals	**14**		**8,065**	**100**	**100**	**84.0**
Station 2						
Rainbow trout	39	172-560	9,853	83	83	234.0
Brown trout	8	177-333	2,059	17	17	48.0
Totals	**47**		**11,912**	**100**	**100**	**282.0**
Station 3						
Rainbow trout	54	118-380	10,726	93	90	280.8
Brown trout	4	251-360	1,218	7	10	20.8
Totals	**58**		**11,944**	**100**	**100**	**301.6**
Station 4						
Rainbow trout	35	220-412	7,669	95	82	210.0
Brown trout	2	229-534	1,647	5	18	12.0
Totals	**37**		**9,316**	**100**	**100**	**222.0**
Station 5						
Rainbow trout	8	199-297	1,150	57	24	48.0
Brown trout	6	237-597	3,736	43	76	36.0
Totals	**14**		**4,886**	**100**	**100**	**84.0**
Station 6						
Rainbow trout	3	235-326	650	21	24	18.0
Brown trout	11	230-351	2,042	79	76	66.0
Totals	**14**		**2,692**	**100**	**100**	**84.0**
Station 7						
Rainbow trout	45	145-393	8,549	90	89	270.0
Brown trout	5	245-336	1,048	10	11	30.0
Totals	**50**		**9,597**	**100**	**100**	**300.0**
Station 8						
Rainbow trout	24	215-435	6,117	92	65	144.0
Brown trout	2	489-560	3,364	8	35	12.0
Totals	**26**		**9,481**	**100**	**100**	**156.0**
Station 9						
Rainbow trout	30	153-583	8,011	81	79	180.0
Brown trout	7	212-376	2,129	19	21	42.0
Totals	**37**		**10,140**	**100**	**100**	**222.0**
Station 10						
Rainbow trout	9	207-347	2,696	75	27	54.0
Brown trout	3	550-652	7,215	25	73	18.0
Totals	**12**		**9,911**	**100**	**100**	**72.0**
Station 11						
Rainbow trout	23	192-600	7,623	100	100	138.0
Brown trout	0			0	0	0.0
Totals	**23**		**7,623**	**100**	**100**	**138.0**
Station 12						
Rainbow trout	33	196-370	10,107	80	62	198.0
Brown trout	8	317-584	6,163	20	38	48.0
Totals	**41**		**16,270**	**100**	**100**	**246.0**
Overall total	**373**		**111,837**			**184.2**

Norris Tailwater
2001

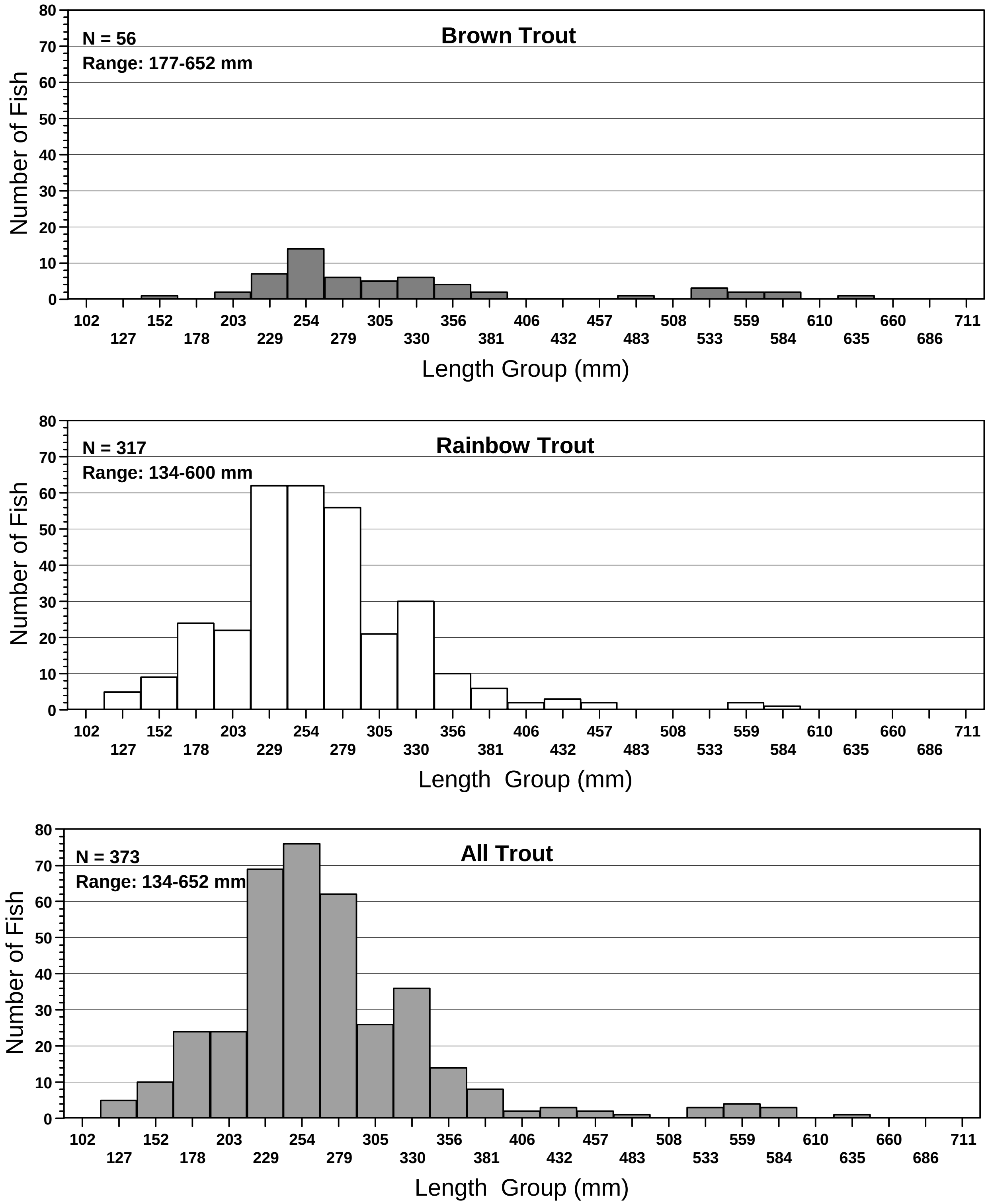


Figure 3-2. Length frequency distributions for trout from 12 monitoring stations on the Norris tailwater in 2001. Length groups correspond to 5-25 inch classes.

3.2.2 Wilbur (Watauga River)

Study Area

The Watauga River flows northwest from the mountains of northwestern North Carolina into Carter County, Tennessee. It is impounded near Hampton, forming Watauga Reservoir (2,603 ha). Most of the reservoir's watershed (1,213 km^2) is forested and much of the Tennessee portion lies within the CNF. Wilbur Dam is located 4.5 km (~3 mi.) downstream of Watauga Dam and impounds a small reservoir. The Watauga River below Wilbur Dam supports a 26-km (16-mi.) fishery for rainbow and brown trout before entering Boone Reservoir. Surface area of the tailwater at base flow is 135 ha (Bettoli 1999). Put-and-take and put-grow-and-take fisheries are provided by annually stocking fingerling and adult trout, although there is some natural reproduction, particularly by brown trout (Banks and Bettoli 2000). General trout angling regulations apply except in a 4.3-km (2.7-mi) 'Quality Zone' (QZ) between Smalling Bridge and the Hwy. 400 bridge at Watauga (Figure 3-3). A 2-fish creel limit and 356-mm minimum size limit are in effect within the QZ and only artificial lures may be used (Bivens 1989).

The Watauga River between Elizabethton to Boone Reservoir has a long history of degradation (Bivens 1988). Biological surveys during 1970-1982 documented the presence of only the most pollution-tolerant forms of aquatic life (Mullican and Leming 1970; McKinney et al. 1987). Consequently, few angling opportunities existed at that time. Reductions in effluent toxicity from point sources resulted in recovery of macroinvertebrate and fish communities in the lower portion of the river by the mid to late 1980's. This recovery prompted TWRA to implement a stocking program and later to establish the QZ in 1989. By the 1990's, water quality improvements and TWRA's stocking program had created one of the finest trout fisheries in the state. Bettoli (1999) estimated that the capacity of the Watauga River to overwinter trout (122 kg/ha) was second only to the South Fork of the Holston River in Tennessee. Unfortunately, toxic runoff resulting from a fire at the North American Corporation in February 2000 devastated the trout fishery in the 16-km (10-mile) river section downstream of Elizabethton (Habera et al. 2001a). This area includes the QZ, which was providing improved opportunities for catching larger trout (Habera et al. 1999, 2000; Bettoli 1999). Despite the nearly complete trout kill, the river's benthic community was not substantially impacted and restoration of the trout fishery began later in 2000 (Habera et al. 2001a).

The 12 monitoring sampling stations on the Wilbur tailwater (Figure 3-3) were electrofished by TWRA in March 2001. Location and sampling effort details for these stations are provided in Table 3-3.

Results and Discussion

The 12 Wilbur tailwater electrofishing stations produced 309 trout weighing 53 kg in 2001 (Table 3-4). Previously, Bettoli (1999) estimated that 60% of overwintering trout density (1998-1999) consisted of brown trout, but they represented only 41% of the total catch in 2001. Browns did account for 78% of the catch in the area upstream of the fish kill zone (stations 1-7), but only 13% of the catch within the kill zone (stations 8-12). Given that restoration of the kill zone had been underway less than a year, the brown trout catch there could be expected to roughly reflect, as it did, the relative proportion of brown trout stocked there in 2000 (~25%).

Two of the 17,562 adipose-clipped brown trout released in March 1999 for population estimation purposes (Bettoli 1999) were recaptured in 2001. The clipped fish averaged 180 mm when released, 260 mm (n = 30; range, 218-314 mm) in March 2000, and 315 mm (range, 290-340 mm) in 2001. Growth rates for these fish were 6.7 mm/month for the first year, 4.6 mm/month for the second year, and 5.6 mm/month overall. Tagged brown trout (mean length, 193 mm) released in March 1998 and recaptured in March 1999 had a similar first year growth rate (6.3 mm/month; Bettoli 1999).

The overall 2001 CPUE estimate for all trout was 154.5 fish/h (rainbows, 91fish/h; browns, 63.5 fish/h). Catch rates ranged from 30-468 fish/h at the 12 stations and, unlike in 2000, three of the four highest catch rates were obtained in the fish kill zone (Table 3-4). Only 2.4 fish/h were collected in the fish kill zone in 2000 (Habera et al. 2001a), but CPUE increased to 210 fish/h at these stations in 2001 (Table 3-4) and exceeded the catch rates for the seven upstream stations (115 fish/h). Bettoli (1999) reported trout catch rates of 127 fish/h (overall), 163 fish/ha (stations 1-7), and 78 fish/ha (stations 8-12) for March 1999. Despite the higher overall CPUE at stations 8-12 in 2001, most of the larger trout were captured at the upstream stations. The catch rate for trout ?356 mm was 3.6 fish/h (all rainbows) at stations 8-12, but 10.3 fish/h at the upstream stations (all brown trout). It will likely take a few more years for browns in the fish kill zone (which includes the QZ) to exceed 356 mm and begin contributing appreciably to catch rates for this size class.

Most rainbow trout in the 2001 sample (80%) were in the 203-254 mm size classes and most brown trout (52%) were in the 203-279 mm size classes, with another 24% in the 127-152 mm range (Figure 3-4). Only a few “quality-size” (?356 mm) rainbow trout were collected in 2001 (Figure 3-4), and all of these were collected at stations 8-12, although previous sampling efforts (Bivens et al. 1998; Habera et al. 1999, 2000, 2001a; Bettoli 1999) have produced few such fish in the upper part of the river (stations 1-7). Many more rainbows ?356 mm had been present in the lower portion of the river, particularly in the QZ, but these were lost in the fish kill. Nine percent of the brown trout collected in 2001 exceeded 356 mm, but the large specimens (>500 mm) sometimes captured at the downstream stations are no longer present.

Restoration of the Wilbur tailwater trout fishery impacted by the fish kill began in the spring of 2000 and has already succeeded in substantially increasing the abundance of catchable-sized trout. Initial stocking emphasized fingerlings, as they exhibit the best growth, have the best chance for long-term survival in the river (Bettoli 1999), and will ultimately facilitate recovery of the kill zone trout fishery. Over 22,000 fingerling brook trout were also stocked in the QZ in 2001 and more will be released in 2002. If successful, these fish will provide an added dimension to the Wilbur tailwater trout fishery. The trout stocking history for the entire Wilbur tailwater since 1990 is provided below:

Year	Rainbow Trout	Brown Trout	Brook Trout	Total
1990	48,769	--	--	48,769
1991	37,928	342	--	38,271
1992	57,195	6,720	--	63,915
1993	119,537	4,000	--	123,537
1994	23,014	3,937	--	26,951
1995	54,873	17,298	--	72,171
1996	88,104	8,750	--	96,854
1997	82,797	18,027	--	100,824
1998	92,916	9,275	--	102,191
1999	143,926	18,941	--	162,867
2000	206,963	36,442	--	243,405
2001	149,919	13,905	22,875	186,699
Mean	92,162	11,470		105,538

TVA documented a general increase in fishing pressure on the Wilbur tailwater during 1990-1998, with a 9-year mean of 60,413 angler-h/year. Trout (primarily rainbows) were harvested at an average rate of 0.21 fish/h during 1991-1997. Bettoli (1999) estimated 65,188 hours of fishing pressure (representing 20,564 trips) on the Watauga River between 28 March and 7 November 1998. Anglers caught 1.40 fish/h and harvested trout at the rate of about 0.25 fish/h (Bettoli 1999), which was similar to the rates reported by TVA for most years. Return rates for stocked trout were 27% for rainbows and 15% for brown trout, which are intermediate compared with return rates for other Tennessee tailwaters (Bettoli 1999). Another creel survey of the Wilbur tailwater is planned for 2002.

Management Recommendations

Restoration of the trout fishery in the lower portion of the Wilbur tailwater is proceeding as planned and TWRA is optimistic that these efforts will ultimately be successful as long as water quality in the river is maintained. A few larger trout (?356 mm) were present in the fish kill zone in 2001and their production should begin to increase, particularly within the QZ, given the growth rates (6-14 mm/month) reported by Bettoli (1999). It may take several more years, however, to achieve the size and age structures present before the fish kill. Progress of the recovery will be monitored annually and adjustments to stocking allocations will be made, if necessary, to facilitate the recovery process. No changes to the angling regulations already in place were recommended in 2001 and none are currently considered necessary.

Wilbur Tailwater

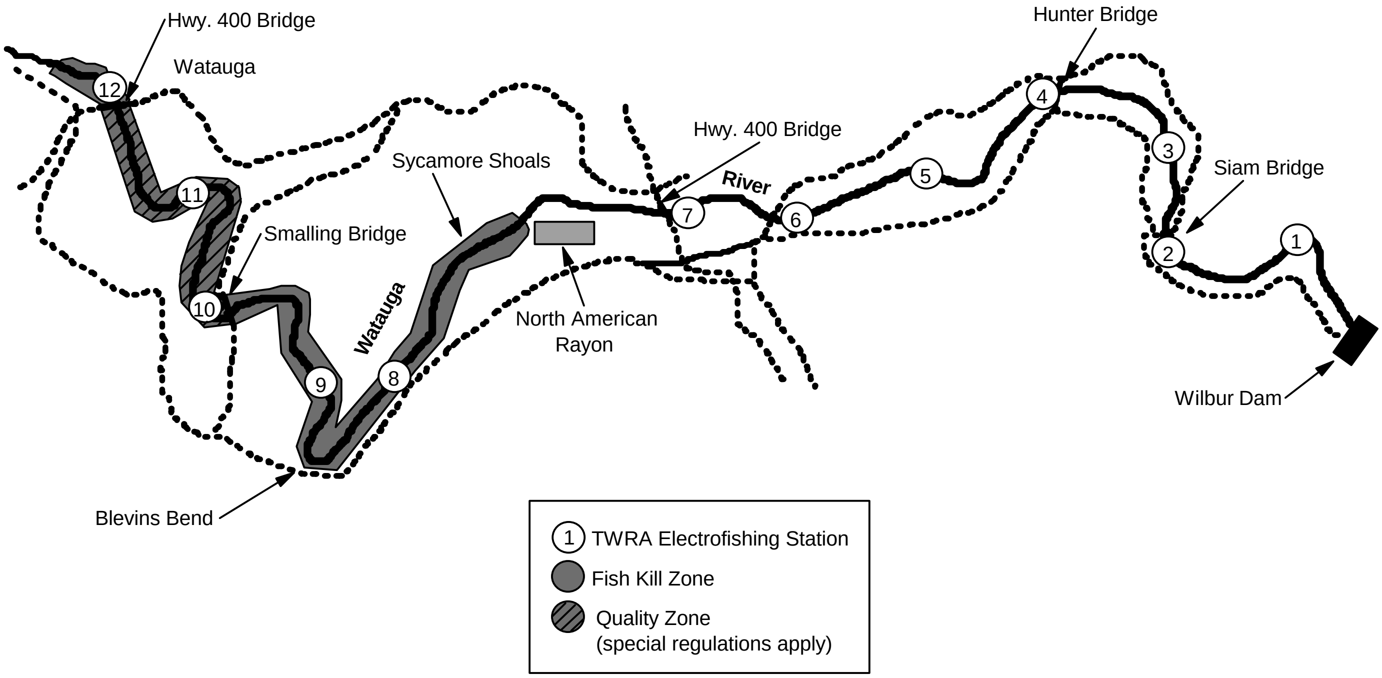


Figure 3-3. Locations of the Wilbur tailwater (Watauga River) monitoring stations.

Table 3-3. Location and sampling information for the 12 electrofishing stations on the Wilbur tailwater, 13 March 2001.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420010301	Carter	Elizabethton 207 SW	362107N-820759W	06010103-19,0	33.0	601	400 V DC 120 PPS, 5 A
2	420010302	Carter	Elizabethton 207 SW	362053N-820855W	06010103-19,0	32.0	600	530 V DC 120 PPS, 4 A
3	420010303	Carter	Elizabethton 207 SW	362149N-820916W	06010103-19,0	30.3	600	530 V DC 120 PPS, 5 A
4	420010304	Carter	Elizabethton 207 SW	362206N-821007W	06010103-18,0	29.5	600	400 V DC 120 PPS, 4 A
5	420010305	Carter	Elizabethton 207 SW	362130N-821046W	06010103-18,0	28.4	600	530 V DC 120 PPS, 4 A
6	420010306	Carter	Elizabethton 207 SW	362118N-821212W	06010103-18,0	27.0	610	400 V DC 120 PPS, 4 A
7	420010307	Carter	Elizabethton 207 SW	362137N-821337W	06010103-12,2	25.9	600	530 V DC 120 PPS, 5 A
8	420010308	Carter	Johnson City 198 SE	361956N-821601W	06010103-12,2	22.4	602	400 V DC 120 PPS, 5 A
9	420010309	Carter	Johnson City 198 SE	362002N-821609W	06010103-12,0	21.8	600	530 V DC 120 PPS, 5 A
10	420010310	Carter	Johnson City 198 SE	362044N-821659W	06010103-12,0	20.0	601	400 V DC 120 PPS, 5 A
11	420010311	Carter	Johnson City 198 SE	362127N-821726W	06010103-10,0	18.7	600	530 V DC 120 PPS, 5 A
12	420010312	Carter	Johnson City 198 SE	362225N-821809W	06010103-10,0	17.3	601	400 V DC 120 PPS, 5 A

Table 3-4. Catch data for the12 electrofishing stations on the Wilbur tailwater (Watauga River) sampled 13 March 2001.

Site #	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)	CPUE (fish/h)
Station 1						
Rainbow trout	12	126-277	1,445	43	34	72.0
Brown trout	16	115-415	2,847	57	66	96.0
Totals	**28**		**4,292**	**100**	**100**	**168.0**
Station 2						
Rainbow trout	3	230-269	473	16	13	18.0
Brown trout	16	147-365	3,090	84	87	96.0
Totals	**19**		**3,563**	**100**	**100**	**114.0**
Station 3						
Rainbow trout	3	239-275	519	27	13	18.0
Brown trout	8	250-470	3,403	73	87	48.0
Totals	**11**		**3,922**	**100**	**100**	**66.0**
Station 4						
Rainbow trout	2	191-244	221	11	7	12.0
Brown trout	16	122-448	3,111	89	93	96.0
Totals	**18**		**3,332**	**100**	**100**	**108.0**
Station 5						
Rainbow trout	3	247-265	509	8	8	18.0
Brown trout	33	140-386	5,801	92	92	198.0
Totals	**36**		**6,310**	**100**	**100**	**216.0**
Station 6						
Rainbow trout	0			0	0	0.0
Brown trout	6	152-400	1,613	100	100	36.0
Totals	**6**		**1,613**	**100**	**100**	**36.0**
Station 7						
Rainbow trout	7	199-255	1,025	44	29	42.0
Brown trout	9	151-435	2,510	56	71	54.0
Totals	**16**		**3,535**	**100**	**100**	**96.0**
Station 8						
Rainbow trout	4	208-300	662	80	93	24.0
Brown trout	1	163	51	20	7	6.0
Totals	**5**		**713**	**100**	**100**	**30.0**
Station 9						
Rainbow trout	27	194-340	3,465	75	88	162.0
Brown trout	9	137-195	493	25	12	54.0
Totals	**36**		**3,958**	**100**	**100**	**216.0**
Station 10						
Rainbow trout	39	185-442	6,513	93	94	234.0
Brown trout	3	232-235	386	7	6	18.0
Totals	**42**		**6,899**	**100**	**100**	**252.0**
Station 11						
Rainbow trout	73	189-470	11,900	94	97	438.0
Brown trout	5	155-241	425	6	3	30.0
Totals	**78**		**12,325**	**100**	**100**	**468.0**
Station 12						
Rainbow trout	9	236-298	2,110	64	75	54.0
Brown trout	5	191-237	697	36	25	30.0
Totals	**14**		**2,807**	**100**	**100**	**84.0**
Overall total	**309**		**53,269**			**154.5**

Wilbur Tailwater
2001

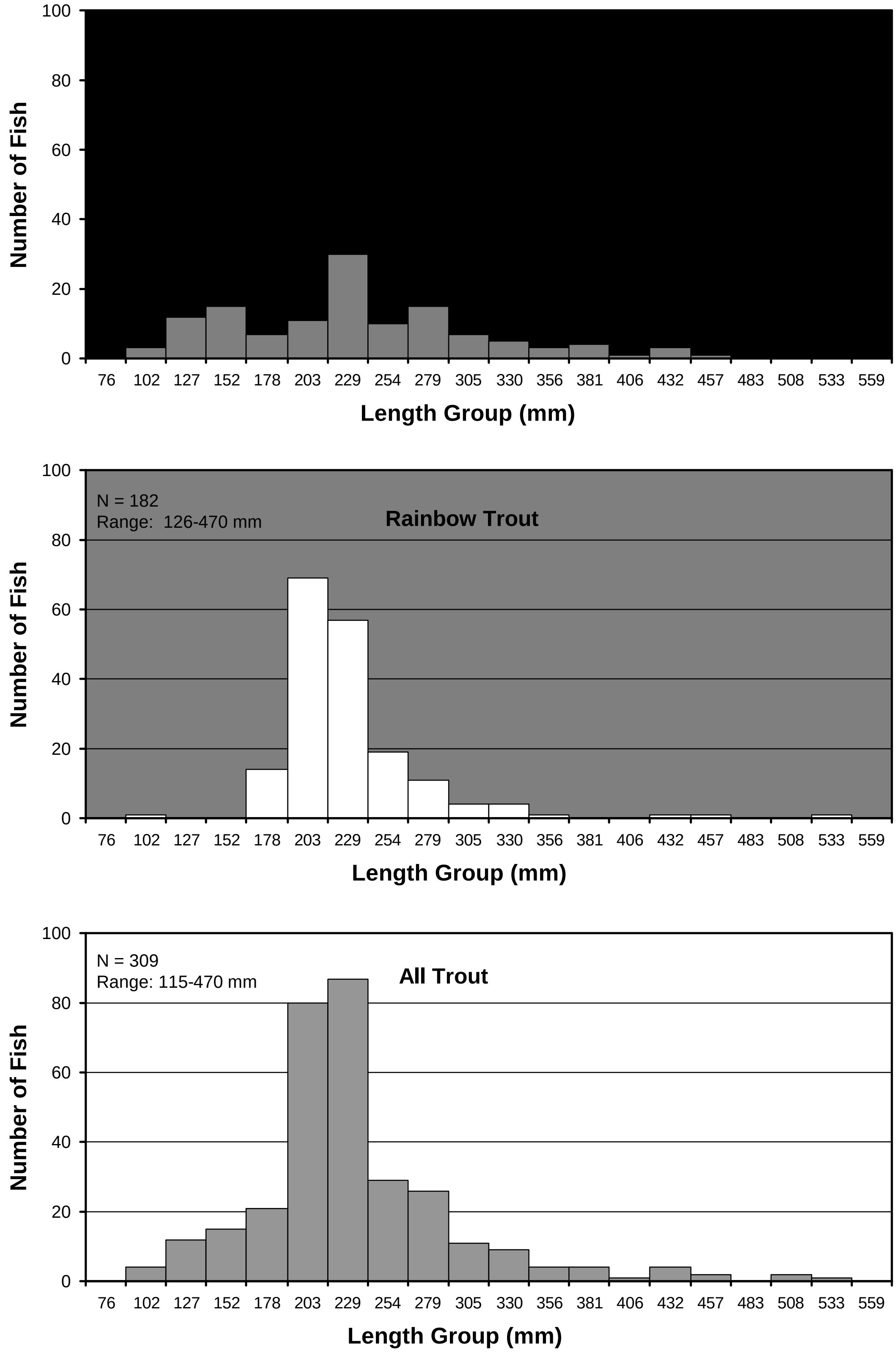


Figure 3-4. Length frequency distributions for trout from 12 monitoring stations on the Wilbur tailwater (March 2001).

3.2.3 South Holston (South Fork Holston River)

Study Area

The South Holston tailwater extends approximately 22.5 km between the headwaters of Boone Reservoir and South Holston Dam. The tailwater was created in 1951 when the Tennessee Valley Authority (TVA) completed construction of the dam at South Fork Holston River Mile (SFHRM) 49.8 in Sullivan County, Tennessee. The reservoir upstream of the dam has a drainage area of 1,821 km^2 and extends upstream for 38.1 km into Washington County, Virginia. Much of the watershed is forested and includes portions of the CNF (Tennessee) and the Jefferson National Forest (Virginia). The tailwater has an average width of 61 m and a surface area of about 137 ha.

Turbine discharges from South Holston Dam historically experienced a period of low dissolved oxygen (DO) during summer and fall. While this DO depression was not as severe as those in other TVA tailwaters, it was not beneficial to the trout fishery. To address concerns about low DO levels and a lack of minimum flow in the tailwater, TVA constructed an aerating labyrinth weir at SFHRM 48.5 as part of its Reservoir Releases Improvement Program. The weir, completed in December 1991, maintains a minimum flow of 2.55 m^2/s (90 CFS) in the tailwater and recovers approximately 40-50% of the oxygen deficit as water passes over it (Yeager et al. 1993). The turbines are typically pulsed twice daily to maintain the weir pool. Additionally, releases from South Holston Dam are now being aerated via turbine venting aided with hub baffles. The weir and the turbine improvements combine to help maintain the target DO concentration of 6 ppm.

The South Fork Holston River tailwater has been managed as a put-and-take and put-grow-and-take trout fishery with annual stockings of both catchable and fingerling rainbow and brown trout. The first trout stockings occurred in 1952 when both rainbow trout and brook trout fingerlings and adults were stocked. Recent investigations conducted for TWRA (Bettoli et al. 1999) have documented substantial natural reproduction (particularly by brown trout) and an overwintering biomass (80% brown trout) of 170-232 kg/ha. Regulations banning the snagging of any fish at any time went into effect in 1999 to protect large brown trout during the spawning season. Establishment of a quality zone with special regulations was considered, but never officially proposed, during 1992-1993. Later, a quality trout management regulation based on a 406-559 mm (16-22 in.) protected slot limit was proposed and established for the entire tailwater in 1999. Additionally, fishing was prohibited during November through January at two major trout spawning areas to protect the vulnerable spawners and potentially improve recruitment. The protected slot limit became effective in March 2000 and the spawning area closures began in November 1999.

A study of east Tennessee tailwaters conducted in the early 1950's (Pfitzer 1954) included the South Holston tailwater, but TWRA made no subsequent surveys of the South Holston tailwater until 1995. Two monitoring sites were established on the South Holston tailwater in 1995 (Bivens et al. 1996) and were sampled annually (summer) through 1998 to begin compiling a database on the existing fishery. These efforts were replaced in 1999 with the 12 stations (Figure 3-5) and protocol established by Bettoli et al. (1999). Sampling in 2001 was conducted in early March (pre-stocking) and all subsequent efforts will also occur at this time. Sample site location and effort details are summarized in Table 3-5.

Results and Discussion

The 12 sites on the South Holston tailwater produced 236 trout weighing 49.51 kg in 2001 (Table 3-6). The samples included 66 rainbows (28%) and 170 browns (72%) ranging from 93 to 690 mm (Table 3-6; Figure 3-6). Eleven percent of the trout captured (two rainbows, 24 browns) were "quality-size" fish (?356 mm). Six percent of the trout captured (one rainbow, 12 browns) were within the protected slot range (406-559 mm). The largest trout collected was a 690 mm (27 inch class) brown trout that weighed 3.37 kg (7.4 lb). The large number of 76-203 mm brown trout (Figure 3-6) indicates that excellent natural reproduction during the previous year produced a strong 2000 cohort. The length frequency distribution for rainbow trout (127-178 mm fish) indicates the presence of some natural reproduction in 2000 as well (Figure 3-6).

The total trout CPUE estimate was 118.0 fish/h and ranged from 18 to 288 fish/h (Table 3-6). CPUE estimates for all recent samples from the South Holston tailwater are provided below:

	South Holston tailwater trout CPUEs (fish/h)		
Year	**Rainbow trout**	**Brown trout**	**Total**
1997[1]	45.0	25.0	70.0
1999	40.0	105.5	145.5
2000	43.0	67.0	110.0
2001	33.0	85.0	118.0
Mean	40.3	70.6	110.9

[1]Data are from Bettoli et al. (1999) and represent the same 12 stations sampled during 1999-2001.

Total catch and overall CPUE for 2001 were comparable to the corresponding values for 2000 (220 trout; 110.0 fish/h). Mean CPUE for all samples since 1997 (110.9 fish/h) was comparable to the average (95.9 fish/h) for electrofishing samples at the two previous TWRA sites during 1995-1998 (Bivens et al. 1996, 1997, 1998; Habera et al. 1999). The proportion of quality-size trout (?356 mm) in 2001 was also comparable to 2000 (12%). Since 1999, CPUEs for larger rainbow and brown trout (?356 mm and 406-559 mm) have generally declined (see below).

Year	CPUE (fish/h) ? 356 mm Rainbow trout	 Brown trout	 Total
1997[1]	5.0	8.5	13.5
1999	6.5	32.0	38.5
2000	3.5	13.5	17.0
2001	1.0	12.0	13.0
Mean	4.0	16.5	20.5
	CPUE (fish/h) 406-559 mm		
1997[1]	0.0	7.0	7.0
1999	2.5	18.0	20.5
2000	0.0	8.0	8.0
2001	0.5	6.0	6.5
Mean	0.8	9.8	10.5

[1]Data are from Bettoli et al. (1999) and represent the same 12 stations sampled during 1999-2001.

The South Fork Holston tailwater was stocked with about 139,000 trout during calendar year 2001. Of this total, about 17,500 were brown trout averaging ~154 mm in length. The remainder was rainbow trout, including about 74,000 fingerlings ~102 mm in length. The trout stocking history for the South Fork Holston River tailwater since 1990 is provided below:

Year	Rainbow Trout	Brown Trout	Total
1990	60,358	--	60,358
1991	43,681	10,010	53,691
1992	48,376	28,781	77,157
1993	94,578	--	94,578
1994	2,400	10,009	12,409
1995	68,947	20,003	88,950
1996	92,423	16,531	108,954
1997	51,222	17,512	68,734
1998	90,551	17,035	107,586
1999	142,884	13,133	156,017
2000	147,770	4,457	152,227
2001	121,588	17,505	139,093
Mean	80,398	12,915	93,313

TVA documented a doubling of angling pressure on the South Holston tailwater between 1990 and 1995 (60,00 to 122,000 angler hours/year), after which pressure remained relatively constant through 1998. The 9-year mean was 93,419 angler-h/year (TVA data). Harvest rates, based on 7-year means (1991-1997), were 0.120 fish/h for rainbow trout, 0.019 fish/h for brown trout, and 0.139 fish/h overall. Bettoli et al. (1999) documented a total fishing pressure of 100,844 hours representing 29,028 trips between March and October 1997. Average trip length was 3.47 h and anglers caught 4.65 trout per trip (1.1 trout/h). Anglers harvested 1.31 trout per trip on average, yielding a harvest rate of about 0.38 fish/h. Return rates for stocked trout were 47% (rainbows) and 24% (brown trout) based on 1997 data (Bettoli et al. 1999).

Management Recommendations

The South Holston tailwater has developed into one of the best tailwater trout fisheries in the Southeast, as well as the entire U.S. (Bettoli et al. 1999). The abundance of large brown trout and the substantial amount of natural reproduction (yielding wild fish) make this a relatively unique resource in Tennessee. The new 16-22 in. protected slot limit, along with the protection of major trout spawning areas, represent a refocusing of management on maintaining (and potentially enhancing) this quality trout fishery. However, the new management direction has not been in effect long enough to permit an assessment of its efficacy. It is recommended that monitoring of the 12 established sample sites continue each year to further supplement the database for this tailwater and to evaluate the regulation changes. Creel data should also be collected as often as possible and another creel/angler preference survey (directed by Dr. Bettoli) is scheduled for 2002. It is also recommended that the current (1999-2000) stocking rates be maintained.

South Holston Tailwater

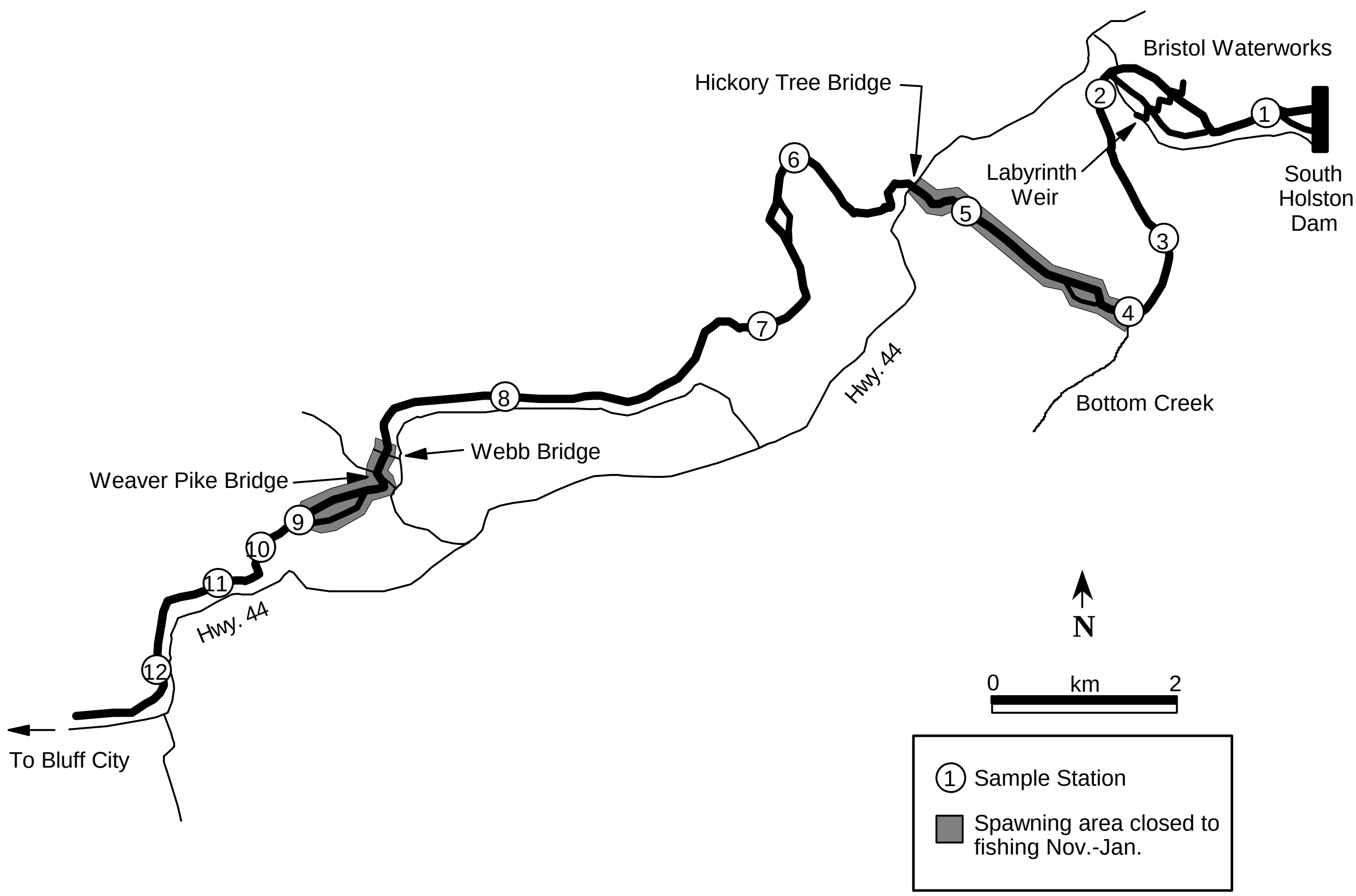


Figure 3-5. Locations of the 12 South Holston tailwater sampling stations.

Table 3-5. Location and sampling information for the 12 stations on the South Holston tailwater, 7 March 2001.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420010201	Sullivan	Holston Valley 206 SE	363125N-820535W	06010102-14,0	49.5	600	354 V DC 120 PPS, 5 A
2	420010202	Sullivan	Holston Valley 206 SE	363130N-820655W	06010102-14,0	48	605	200 V DC 120 PPS, 5 A
3	420010203	Sullivan	Holston Valley 206 SE	363035N-820625W	06010102-14,0	46.8	601	200 V DC 120 PPS, 5 A
4	420010204	Sullivan	Holston Valley 206 SE	363015N-820640W	06010102-13,2	46.4	600	354 V DC 120 PPS, 5 A
5	420010205	Sullivan	Bristol 206 SW	363045N-820740W	06010102-13,2	45.3	600	354 V DC 120 PPS, 5 A
6	420010206	Sullivan	Bristol 206 SW	363050N-820840W	06010102-13,2	44.2	602	200 V DC 120 PPS, 5 A
7	420010207	Sullivan	Bristol 206 SW	363035N-820855W	06010102-13,2	43	600	354 V DC 120 PPS, 5 A
8	420010208	Sullivan	Bristol 206 SW	362943N-821050W	06010102-13,2	40.6	601	200 V DC 120 PPS, 5 A
9	420010209	Sullivan	Keenburg 207 NW	362855N-821220W	06010102-13,2	38.6	600	354 V DC 120 PPS, 5 A
10	420010210	Sullivan	Keenburg 207 NW	362845N-821230W	06010102-13,2	38.4	600	200 V DC 120 PPS, 5 A
11	420010211	Sullivan	Keenburg 207 NW	362840N-821255W	06010102-13,1	38	600	354 V DC 120 PPS, 5 A
12	420010212	Sullivan	Keenburg 207 NW	362756N-821315W	06010102-13,1	37.1	600	200 V DC 120 PPS, 5 A

Table 3-6. Catch data for the 12 electrofishing stations on the South Holston tailwater (South Fork Holston River) sampled 7 March 2001.

Site #	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)	CPUE (fish/h)
Station 1						
Rainbow trout	10	258-550	4,802	77	81	60.0
Brown trout	3	287-322	1,115	23	19	18.0
Totals	**13**		**5,917**	**100**	**100**	**78.0**
Station 2						
Rainbow trout	2	172-290	268	8	10	12.0
Brown trout	23	127-366	2,475	92	90	138.0
Totals	**25**		**2,743**	**100**	**100**	**150.0**
Station 3						
Rainbow trout	2	142-191	101	4	4	12.0
Brown trout	46	93-335	2,326	96	96	276.0
Totals	**48**		**2,427**	**100**	**100**	**288.0**
Station 4						
Rainbow trout	1	237	115	5	3	6.0
Brown trout	19	127-434	3,389	95	97	114.0
Totals	**20**		**3,504**	**100**	**100**	**120.0**
Station 5						
Rainbow trout	7	233-292	1,650	35	46	42.0
Brown trout	13	170-298	1,949	65	54	78.0
Totals	**20**		**3,599**	**100**	**100**	**120.0**
Station 6						
Rainbow trout	6	164-330	1,229	43	15	36.0
Brown trout	8	156-690	7,126	57	85	48.0
Totals	**14**		**8,355**	**100**	**100**	**84.0**
Station 7						
Rainbow trout	5	176-294	858	33	28	30.0
Brown trout	10	131-437	2,202	67	72	60.0
Totals	**15**		**3,060**	**100**	**100**	**90.0**
Station 8						
Rainbow trout	5	189-268	624	36	13	30.0
Brown trout	9	179-511	4,094	64	87	54.0
Totals	**14**		**4,718**	**100**	**100**	**84.0**
Station 9						
Rainbow trout	8	189-293	1,285	35	22	48.0
Brown trout	15	170-450	4,510	65	78	90.0
Totals	**23**		**5,795**	**100**	**100**	**138.0**
Station 10						
Rainbow trout	3	250-291	558	100	100	18.0
Brown trout	0			0	0	0.0
Totals	**3**		**558**	**100**	**100**	**18.0**
Station 11						
Rainbow trout	15	162-332	2,415	45	39	90.0
Brown trout	18	158-420	3,775	55	61	108.0
Totals	**33**		**6,190**	**100**	**100**	**198.0**
Station 12						
Rainbow trout	2	188-278	302	25	11	12.0
Brown trout	6	167-440	2,337	75	89	36.0
Totals	**8**		**2,639**	**100**	**100**	**48.0**
Overall total	**236**		**49,505**			**118.0**

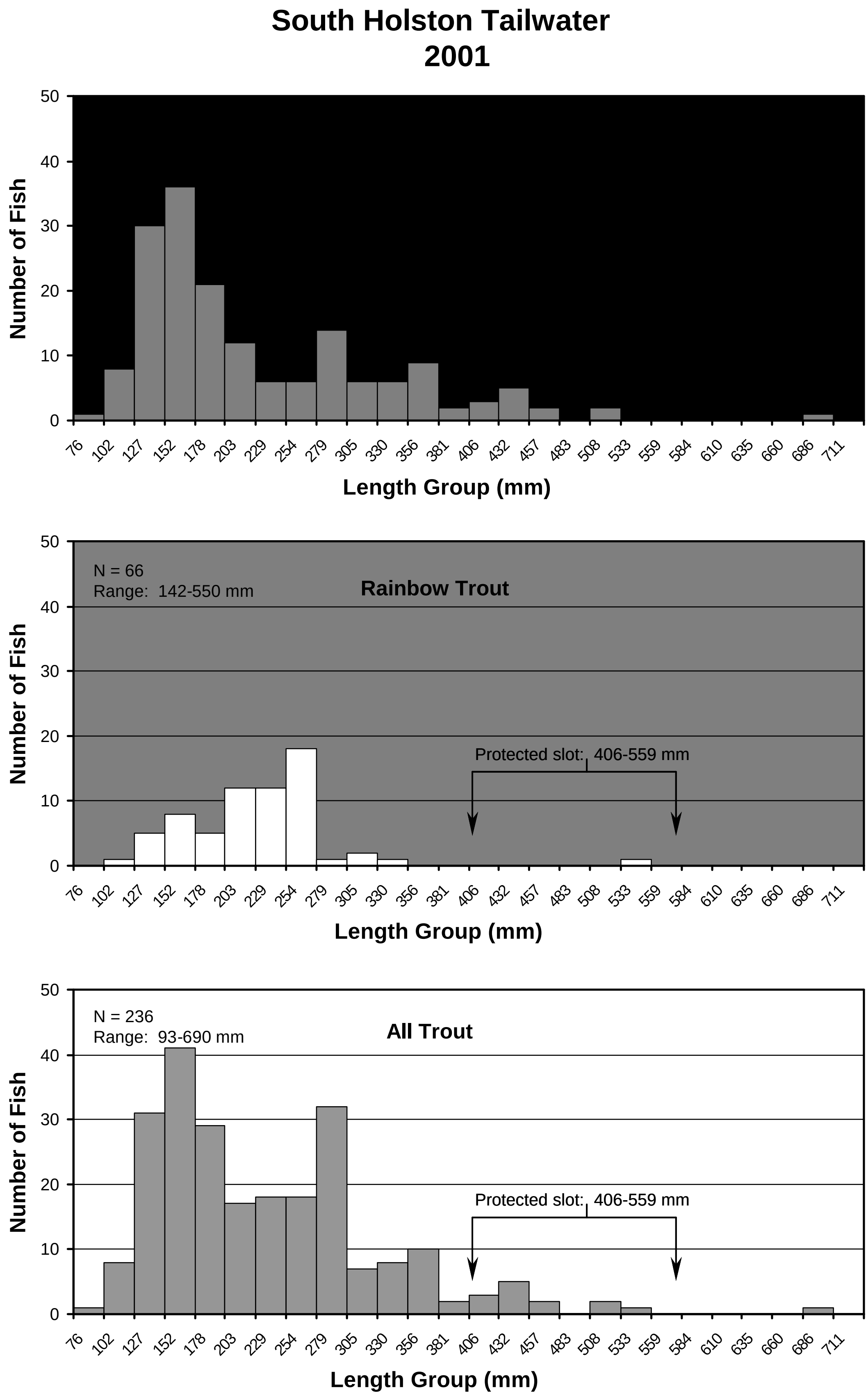


Figure 3-6. Length frequency distributions for trout from 12 monitoring stations on the South Holston tailwater (March 2001).

4. SUMMARY

? Twenty-two stations on 14 wild trout streams in the Tellico/Little Tennessee, French Broad, Nolichucky, Watauga, and South Fork Holston watersheds were sampled quantitatively during 2001. Overall, 358 quantitative (three-pass depletion) samples have been conducted in 122 different wild trout streams in 11 east Tennessee counties since 1991. Long-term monitoring stations on Tellico River, North River, Rocky Fork, Left Prong Hampton Creek, Right Prong Middle Branch, Doe Creek (high-elevation, allopatric brook trout), and Beaverdam Creek were sampled in 2001. Bald River and Laurel Fork were dropped from the monitoring group in 2001 and Laurel Creek (Johnson County) was added.

? The dry conditions and low stream flow dating back to the summer of 1998 moderated somewhat in 2001, but declining trends in wild trout abundance at several long-term monitoring stations over the past four years illustrate the effects of reduced flows and increased temperature. Wild trout abundance was at or near the lowest level observed since sampling began at several monitoring stations in 2001 (including North River, Rocky Fork, and Left Prong Hampton Creek). Population structures have been affected as well, with decreases in the abundance of larger fish (?229 mm). Additional impacts will depend upon the duration of the dry conditions, but unless they continue for several more years, wild trout abundances should recover relatively quickly as they did following the severe, region-wide flooding that occurred in 1994.

? Based on data collected during 1991-2000, total wild trout density in Tennessee streams averages 1,392 fish/ha (95% C. I., 1,224-1,560 fish/ha; median, 1,062 fish/ha) and standing crop averages 31.41 kg/ha (95% C.I., 27.47-35.34 kg/ha; median, 25.14 kg/ha). Total trout standing crop in streams with alkalinities ?40 mg/l (as $CaCO_3$) tends to be higher. Brook, rainbow, and brown trout populations averaged 21.37, 28.91, and 19.27 kg/ha, respectively. Less than 3% of all wild rainbow trout collected in quantitative samples (1991-2000) were ?229 mm, whereas 15% of all wild brown trout were ?229 mm. Although <1% of all brook trout exceeded 229 mm, about 14% were ?152 mm (the legally-harvestable size).

? Because of the relative stability and quality of the benthic communities observed during previous monitoring efforts, most sampling in wild trout monitoring streams was discontinued in 2001. Benthic communities at all sample sites on Tellico River, which receives the discharge from Tellico Hatchery, had relative health classifications of good in 2001, including the site immediately below the hatchery outfall. Benthic samples will be collected at new monitoring stations to generally identify the taxa present and classify relative biological health.

? Relative abundances of brook trout at sympatric–zone monitoring stations on four streams have been stable or increasing since 1998. Continued monitoring of the sympatric brook/ rainbow trout populations in these streams should provide a better understanding of the long-term interactions between these species.

? The new brook trout population in Left Prong Hampton Creek has become established and is growing exceptionally well. Brook trout in the restoration area successfully spawned again during the fall of 2000 and the populations at stations 2 and 3 continued to expand in 2001. Brook trout standing crop at Station 2 (23 kg/ha) has reached the statewide average for other Tennessee populations (about 21 kg/ha) and brook trout standing crop at Station 3 (40 kg/ha) is now nearly double that level. No rainbow trout were collected during the 2001 sampling efforts at stations 2 or 3. The brook trout that were experimentally stocked in Little Jacob Creek in September 2000 also spawned successfully (YOY were collected in August 2001).

? No wild trout were collected for pathogen screening in 2001. The results of tests on previous samples have been negative for most pathogens. Most samples have tested positive for RS (*Renibacterium salmoninarum*), but no clinical signs of disease were present. All completed whirling disease tests completed to date have been negative. The lack of disease problems in Tennessee's wild trout populations is relatively unsurprising; however, Rocky Fork and Laurel Fork will be sampled in 2002 to expand the current database.

? The 12 Norris tailwater monitoring stations produced 373 trout (85% rainbows, 15% browns) weighing 111.84 kg in March 2001. Rainbow trout ranged from 134-600 mm, browns ranged from 177-652 mm, and most fish were in the 203-305 mm size range. Trout ?356 mm ("quality-size" fish) made up 11% of the catch, while about 4% were ?457 mm and about 3% were ?508 mm. The overall CPUE for all trout (182.6 fish/h; range, 72.0-301.8 fish/h) was the highest since monitoring by TWRA began and also exceeded the average catch rates for 1996 (Bettoli and Bohm 1997) and November 1994 (69 fish/h, Bivens et al. 1995). Electrofishing catch rates for trout ?356 mm exceeded 20 fish/h the last two years and also exceed all previous catch rates for fish in this size range.

? Restoration of the trout fishery in the Wilbur tailwater segment impacted by the February 2000 fish kill began in the spring of 2000 and has already succeeded in substantially increasing the abundance of catchable-sized trout. The 12 Wilbur tailwater monitoring stations produced 309 trout weighing 53 kg in March 2001 (59% rainbows, 41% browns). Most trout were in the 203-279 mm size range. The overall 2001 CPUE for all trout was 154.5 fish/h (range, 30-468 fish/h), and three of the four highest catch rates were obtained in the fish kill zone. However, only a few "quality-size" (?356 mm) rainbow trout were collected in 2001 and most of the larger trout were captured at the upstream stations. The catch rate for trout ?356 mm was 3.6 fish/h (all rainbows) in the kill zone, but 10.3 fish/h at the upstream stations (all brown trout).

? The March 2001 samples at the 12 monitoring stations on the South Holston tailwater produced 236 trout (28% rainbows, 72% browns) weighing 49.51 kg. Eleven percent of the trout captured (two rainbows, 24 browns) were "quality-size" fish (?356 mm) and 6% (one rainbow, 12 browns) were within the protected slot range (406-559 mm). The largest trout collected was a 690 mm (27 inch class) brown trout that weighed 3.37 kg (7.4 lb). Excellent natural reproduction by brown trout during late 1999 produced a strong 2000 cohort (and an abundance of 76-203 mm fish in 2001). The total trout CPUE estimate was 118.0 fish/h (range, 18 to 288 fish/h), CPUE for trout ?356 mm was 13.0 fish/h, and CPUE for 406-559 mm fish was 6.5 fish/h. Catch rates for larger trout have generally declined since 1999.

REFERENCES

Banks, S. M., and P. W. Bettoli. 2000. Reproductive potential of brown trout in Tennessee tailwaters. Fisheries Report No. 00-19. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bates, B. N. 1997. A creel survey of the Tellico and North rivers: Comparisons between a stocked and a wild trout stream in Tennessee. M. S. thesis. University of Tennessee, Knoxville, Tennessee.

Behnke, R. J. 1990. Roots, origins, and management of *Salmo trutta*, our most versatile species of trout. Pages 1-2 *in* J. C. Borawa, ed. Brown trout workshop: biology and management. American Fisheries Society, Southern Division, Trout Committee, Asheville, North Carolina.

Behnke, R. J. 1992. Native trout of North America. American Fisheries Society Monograph 6. Bethesda, Maryland.

Bettinger, J. M., and P. W. Bettoli. 2000. Movements and activity of rainbow trout and brown trout in the Clinch River, Tennessee, as determined by radio-telemetry. Fisheries Report No. 00-14. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 1999. Creel survey and population dynamics of salmonids stocked into the Watauga River below Wilbur Dam. Fisheries Report No. 99-41. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2000. Potential impacts of the striped bass on the trout fishery in the Norris Dam tailwater. Fisheries Report No. 00-31. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2001. Management alternatives for the trout fishery in the Clinch River below Norris Dam. Fisheries Report No. 01-04. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2002. Clinch River creel survey results: March-October 2001. Fisheries Report No. 02-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W., and L. A. Bohm. 1997. Clinch River trout investigations and creel survey. Fisheries Report No. 97-39. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W., S. J. Owens, and M. Nemeth. 1999. Trout habitat, reproduction, survival, and growth in the South Fork of the Holston River. Fisheries Report No. 99-3. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D. 1979. Survey of brook trout streams on the Unaka and Nolichucky Ranger Districts, Cherokee National Forest. Internal project report, U.S. Department of Agriculture Forest Service, Cleveland, Tennessee.

Bivens, R. D. 1984. History and distribution of brook trout in the Appalachian region of Tennessee. M. S. thesis. University of Tennessee, Knoxville, Tennessee.

Bivens, R. D. 1988. Region IV stream fishery data collection report: 1986-1987. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D. 1989. Region IV stream fishery data collection report: 1988. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., R. J. Strange, and D. C. Peterson. 1985. Current distribution of the native brook trout in the Appalachian region of Tennessee. Journal of the Tennessee Academy of Science 60:101-105.

Bivens, R. D., and C. E. Williams. 1990. Region IV stream fishery data collection report: 1989. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., M. T. Fagg, and C. E. Williams. 1992. Region IV trout fishery data collection report: 1991. Fisheries Report No. 93-17. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1994. Region IV trout fishery data collection report: 1993. Fisheries Report No. 94-21. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1995. Region IV trout fishery data collection report: 1994. Fisheries Report No. 95-59. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1996. Region IV trout fisheries report: 1995. Fisheries Report No. 96-5. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1997. Region IV trout fisheries report: 1996. Fisheries Report No. 97-2. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1998. Region IV trout fisheries report: 1997. Fisheries Report 98-3. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Boles, H. D. 1980. Clinch River (Norris tailwater) trout fishery investigations 1971-1977. Fisheries Resources Internal Report (Interim Summary Report). U. S. Department of Interior, Fish and Wildlife Service.

Borawa, J. C, C. J. Goudreau, and M. M. Clemmons. 1995. Responses of wild trout populations to supplemental feeding. Federal Aid Project F-24. North Carolina Wildlife Resources Agency, Division of Boating and Inland Fisheries, Raleigh, North Carolina.

Brigham, A. R., W. U. Brigham, and A. Gnilka, editors. 1982. Aquatic insects and oligochaetes of North and South Carolina. Midwest Enterprises, Mahomet, Illinois.

Cada, G. F., J. M. Loar, and M. J. Sale. 1987. Evidence of food limitation of rainbow and brown trout in southern Appalachian soft-water streams. Transactions of the American Fisheries Society 116:692-702.

Carlander, K. D. 1969. Handbook of freshwater fishery biology, volume 1. Iowa State University Press, Ames.

Carter, B. D., and M. S. Carter. In preparation. Trout response to habitat management in three headwater southern Appalachian streams.

Clark, M. E., and K. A. Rose. 1997. Factors affecting competitive dominance of rainbow trout over brook trout in southern Appalachian streams: implications of an individual-based model. Transactions of the American Fisheries Society 126:1-20.

Coulston, P. J., and O. E. Maughan. 1981. Age and growth of trout from two lightly fished North Carolina streams. Journal of the Elisha Mitchell Scientific Society 97:191-193.

Craig, J. F. 1982. A note on growth of trout, *Salmo trutta* L., in afferent streams of Windermere. Journal of Fisheries Biology 20:423-429.

Dunning, D. J., Q. Ross, and J. Gladden. 1982. Evaluation of minimum size limits for St. Lawrence River northern pike. North American Journal of Fisheries Management 2: 171-175.

Durniak, J. P. 1989. A fisheries survey of the upper Chattooga River. Federal Aid Project F-25. Georgia Department of Natural Resources, Game and Fish Division, Atlanta, Georgia.

Durniak, J. P., and R. H. England. 1986. Dynamics of rainbow trout populations in small headwater streams. Federal Aid Project F-25-13. Georgia Department of Natural Resources, Game and Fish Division, Atlanta, Georgia.

Durniak, J. P., L. C. Keefer, and W. R. Ruddell. 1997. Standardized sampling of wild trout streams. Final Report, Dingell-Johnson Project F-25-24. Georgia Department of Natural Resources, Game and Fish Division, Atlanta, Georgia.

England, R. H. 1978. Special trout management regulations. Federal Aid Project F-25-4. Georgia Department of Natural Resources, Game and Fish Division, Atlanta, Georgia.

England, R. H. 1979. Management regulations for native brook trout streams. Federal Aid Project F-25-5. Georgia Department of Natural Resources, Game and Fish Division, Atlanta, Georgia.

Ensign, W. E., R. J. Strange, and S. E. Moore. 1990. Summer food limitation reduces brook and rainbow trout biomass in a southern Appalachian stream. Transactions of the American Fisheries Society 119:894-901.

Etnier, D. A., and W. C. Starnes. 1993. The fishes of Tennessee. The University of Tennessee Press, Knoxville.

Etnier, D. A., J. T. Baxter Jr., S. J. Fraley, and C. R. Parker. 1998. A checklist of the trichoptera of Tennessee. Journal of the Tennessee Academy of Science 73(1-2):53-72.

Flebbe, P. A., and C. A. Dolloff. 1995. Trout use of woody debris and habitat in Appalachian wilderness streams of North Carolina. North American Journal of Fisheries Management 15:579-590.

Fraser, W. C. 1995. Norris tailwater creel survey: fishermen responses to quality regulations. M. S. thesis. University of Tennessee, Knoxville, Tennessee.

Great Smoky Mountains National Park (GSMNP). 1994. 1993 annual aquatic resources summary report. Rep. No. GRSM-INTFM-02. Great Smoky Mountains National Park, Resource Management and Science Division, Gatlinburg, Tennessee.

Habera, J. W., and R. J. Strange. 1993. Wild trout resources and management in the southern Appalachian Mountains. Fisheries 18(1):6-13.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 1999. Region IV trout fisheries report: 1998. Fisheries Report No. 99-4. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2000. Region IV trout fisheries report: 1999. Fisheries Report No. 00-9. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2001a. Region IV trout fisheries report: 2000. Fisheries Report No. 01-03. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. J. Strange, and R. D. Bivens. 2001b. A revised outlook for Tennessee's brook trout. Journal of the Tennessee Academy of Science 76:68-73.

Heidinger, R. C. 1993. Stocking for sport fisheries management. Pages 309-333 *in* C. C. Kohler and W. A. Hubert, eds. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Hill, D. M. 1978. Tailwater trout management. Pages 66-75 in Southeastern trout resource: ecology and management symposium proceedings. USDA Forest Service, Southeastern Forest Experiment Station, Asheville, North Carolina.

Hining, K. J., J. L. West, M. A. Kulp, and A. D Neubauer. 2000. Validation of scales and otoliths for estimating age of rainbow trout from southern Appalachian streams. North American Journal of Fisheries Management 20:978-985.

House, R. A., and P. L. Boehne. 1986. Effects of instream structures on salmonid habitat and populations in Tobe Creek, Oregon. North American Journal of Fisheries Management 6:38-46.

Jenkins, R. E. and N. M. Burkhead. 1993. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

King, W. 1937. Notes on the distribution of native speckled and rainbow trout in the streams of Great Smoky Mountains National Park. Journal of the Tennessee Academy of Science 12:351-361.

King, W. 1942. Trout management studies at Great Smoky Mountains National Park. Journal of Wildlife Management 6:147-161.

Kriegler, F. J., G. F. McCracken, J. W. Habera, and R. J. Strange. 1995. Genetic characterization of Tennessee's brook trout populations and associated management implications. North American Journal of Fisheries Management 15:804-813.

Kulp, M. A. 1994. A comparative ecology study of two strains of brook trout in Great Smoky Mountains National Park. M. S. thesis. Tennessee Technological University, Cookeville, Tennessee.

Kwak, T. J. and T. F. Waters. 1997. Trout production and water quality in Minnesota streams. Transaction of the American Fisheries Society 126:35-48.

Larson, G. L., and S. E. Moore. 1985. Encroachment of exotic rainbow trout into stream populations of native brook trout in the southern Appalachian Mountains. Transactions of the American Fisheries Society 114:195-203.

Larson, G. L., S. E. Moore, and B. Carter. 1995. Ebb and flow of encroachment by nonnative rainbow trout in a small stream in the southern Appalachian Mountains. Transactions of the American Fisheries Society 124:613-622.

Lenat, D. R. 1993. A biotic index for the southeastern United States: derivation and list of tolerance values, with criteria for assigning water-quality ratings. Journal of the North American Benthological Society 12(3):279-290.

Louton, J. A. 1982. Lotic dragonfly (Anisoptera: Odonata) nymphs of the southeastern United States: identification, distribution and historical biogeography. Doctoral dissertation. The University of Tennessee, Knoxville, Tennessee.

Masterson, S. 1991. Age and growth characteristics of rainbow trout *Oncorhynchus mykiss* in Little River watershed, Great Smoky Mountains National Park. M. S. thesis. Tennessee Technological University, Cookeville, Tennessee.

McMichael, G. A., and C. M. Kaya. 1991. Relations among stream temperature, angling success for rainbow and brown trout, and fishermen satisfaction. North American Journal of Fisheries Management 11:190-199.

McKinney, A. D., D. L. Melgaard, J. A. Wojtowicz, and R. D. Martin. 1987. Restoration of the Watauga River in upper east Tennessee through reduction in textile mill effluent toxicity. Tennessee Department of Health and Environment, Division of Water Pollution Control, Knoxville, Tennessee.

Mohn, L. O., and P. E. Bugas, Jr. 1980. Virginia trout stream and environmental inventory. Federal Aid Project F-32. Virginia Department of Game and Inland Fisheries, Richmond, Virginia.

Moore, S. E., and M. Kulp. 1995. 1994 Annual Report. Great Smoky Mountains National Park, Resource Management Fisheries Division, Gatlinburg, Tennessee.

Mullican, H. N., and E. C. Leming. 1970. Biological conditions of the Watauga River as presented to the Tennessee Stream Pollution Control Board. Tennessee Department of Public Health, Tennessee Stream Pollution Control Board, Nashville, Tennessee.

Nagel, J. W. 1986. Brook trout / rainbow trout headwaters competition studies. Research progress report submitted to Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Nagel, J. W. 1991. Is the decline of brook trout in the southern Appalachians resulting from competitive exclusion and/or extinction due to habitat fragmentation? Journal of the Tennessee Academy of Science 66:141-143.

Nagel, J. W., and J. E. Deaton. 1989. Growth and longevity of rainbow trout in two headwater streams in northeastern Tennessee. Journal of the Tennessee Academy of Science 64:9-12.

Noble, R. L., and T. W. Jones. 1993. Managing fisheries with regulations. Pages 383-402 *in* C. C. Kohler and W. A. Hubert, eds. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

North Carolina Department of Environment, Health and Natural Resources (NCDEHNR). 1995. Standard Operating procedures: biological monitoring. Division of Environmental Management, Water Quality Section.

Pfitzer, D. W. 1954. Investigations of waters below large storage reservoirs in Tennessee. Tennessee Game and Fish Commission, Nashville, Tennessee.

Platts, W. S., and M. L. McHenry. 1988. Density and biomass of trout and char in western streams. U. S. Forest Service General Technical Report INT-241.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott. 1991. Common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication 20, Bethesda, Maryland.

Scott, E. M., K. D. Gardner, D. S. Baxter, and B. L. Yeager. 1996. Biological and water quality responses in tributary tailwaters to dissolved oxygen and minimum flow improvements. Tennessee Valley Authority, Water Management Services, Norris, Tennessee.

Seegrist, D. W., and R. Gard. 1972. Effects of floods on trout in Sagehen Creek, California. Transactions of the American Fisheries Society 101:478-482.

Seehorn, M. E. 1985. Special fishing regulations--southeastern style. Pages 115-121 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Federation of Fly Fishers and Trout Unlimited, Vienna, Virginia.

Shields, R. A. 1950. A survey of east Tennessee trout streams with recommendations for management. Internal report, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Shields, R. A. 1951. Streams of the Tellico and Hiwassee Ranger Districts, Cherokee National Forest. Internal report, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Silsbee, D. G., and G. L. Larson. 1983. A comparison of streams in logged and unlogged areas of Great Smoky Mountains National Park. Hydrobiologia 102:99-111.

Stewart, K. W., and B. P. Stark. 1988. Nymphs of North American stonefly genera (plecoptera). Entomological Society of America. Volume 12.

Strange, R. J., and J. W. Habera. 1992. Wild trout project: 1991 annual report. Publication No. R11-2216-76-001-92. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1993. Wild trout project: 1992 annual report. Publication No. R11-2216-76-001-93. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1994. Wild trout project: 1993 annual report. Publication No. R11-2217-18-001-94. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1995. Wild trout project: 1994 annual report. Publication No. R11-2217-18-001-95. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1996. Wild trout project: 1995 annual report. Publication No. R11-2217-93-001-96. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1997. Wild trout project: 1996 annual report. Publication No. R11-2217-93-001-97. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1998a. Wild trout project: 1997 annual report. Publication No. R11-2217-93-002-98. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1998b. No net loss of brook trout distribution in areas of sympatry with rainbow trout in Tennessee streams. Transactions of the American Fisheries Society 127:434-440.

Swink, W. D. 1983. Survey of stocking of tailwater trout fisheries in the southern United States. Progressive Fish-Culturist 45(2):67-71.

Tarzwell, C. M. 1939. Changing the Clinch River into a trout stream. Transactions of the American Fisheries Society 68:228-233.

Tatum, R. 1968. Brook trout streams in upper east Tennessee. Internal memorandum, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Tennessee Valley Authority (TVA). 1980. Improving reservoir releases. TVA Office of Natural Resources and Environmental Development, Knoxville, Tennessee.

Tennessee Wildlife Resources Agency (TWRA). 1998. Stream survey protocols. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Tennessee Wildlife Resources Agency (TWRA). 2000. Strategic wildlife resources management plan for the start of a new millennium. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

U.S. Fish and Wildlife Service (USFWS). 1997. National wild fish health survey protocols and procedures. Division of Fish Hatcheries. Washington, D.C.

Van Deventer, J. S., and W. S. Platts. 1989. Microcomputer software system for generating population statistics from electrofishing data--user's guide for MicroFish 3.0. General Technical Report INT-254. USDA Forest Service, Intermountain Research Station, Ogden, Utah.

Waters. T. F. 1992. Annual production, production/biomass ratio, and the ecotrophic coefficient for management of trout in streams. North American Journal of Fisheries Management 12:34-39.

Whitworth, W. E., and R. J. Strange. 1979. Southern Appalachian brook trout survey. Internal Report, Project E-2-1. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Whitworth, W. E., and R. J. Strange. 1983. Growth and production of sympatric brook and rainbow trout in an Appalachian stream. Transaction of the American Fisheries Society 112:469-475.

Wiggins, G. B. 1996. Larvae of the North American caddisfly genera (trichoptera). 2nd edition. University of Toronto Press, Canada.

Wiley, R. W., R. A. Whaley, J. B. Satake, and M. Fowden. 1993. Assessment of stocking hatchery trout: a Wyoming perspective. North American Journal of Fisheries Management 13:160-170.

Wilkins, L. P. 1978. Wild Trout Stream Survey. Project F-39-R. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Wilkins, L. P., L. Kirkland, and A. Hulsey. 1967. The management of trout fisheries in reservoirs having a self-sustaining warm water fishery. Pages 444-452 *in* C. E. Lane, symposium chairman. Reservoir Fishery Resources Symposium, Reservoir Committee, Southern Division, American Fisheries Society, Bethesda, Maryland.

Wilzbach, M. A. 1985. Relative roles of food abundance and cover in determining the habitat distribution of stream-dwelling cutthroat trout. Canadian Journal of Fisheries and Aquatic Science 42:1668-1672.

Wilzbach, M. A., K. W. Cummins, and J. D. Hall. 1986. Influence of habitat manipulations on interactions between cutthroat trout and invertebrate drift. Ecology 67:898-911.

Yeager, B. L., D. M. Hill, W. M. Seawell, C. M. Alexander, and R. Wallus. 1987. Effects of aeration and minimum flow enhancement on the biota of Norris tailwater. TVA Office of Natural Resources and Environmental Development, Knoxville, Tennessee.

Yeager, B. L., T. A. McDonough, D. A. Kenny. 1993. Growth, feeding, and movement of trout in South Holston tailwater. Water Management Services, WM-94-003. Tennessee Valley Authority, Norris, Tennessee.

APPENDIX A

Wild Trout Streams Sampled Quantitatively
During 1991-2001

Table A-1. Wild trout streams sampled quantitatively during 1991-2001.

Stream	County	Location	Year	Primary species[1]	Total samples
Hiwassee/Ocoee River					
Sulphur Springs Branch	Polk	CNF	1992	RBT	1
Gee Creek	Polk	CNF	1993	RBT	1
Goforth Creek	Polk	CNF	1993	RBT	1
Big Creek	Polk	CNF	1996	RBT	1
Rymer Camp Branch	Polk	CNF	1994	RBT	1
East Fork Wolf Creek	Polk	CNF	1995	RBT	1
Rough Creek	Polk	CNF	1995	RBT	1
Total streams = 7				**Total samples =**	**7**
Tellico/Little Tennessee River					
Kirkland Creek	Monroe	CNF	1991	RBT	1
Meadow Branch	Monroe	CNF	1991,95	BKT	4
Doublecamp Creek	Monroe	CNF	1992	RBT/BNT	2
Citico Creek	Monroe	CNF	1996	RBT/BNT	1
Parson Branch	Blount	Private	1993	RBT	1
Rough Ridge Creek	Monroe	CNF	1995	RBT/BKT	2
Sugar Cove Creek	Monroe	CNF	1995-96	RBT/BKT	3
Tellico River[2]	Monroe	CNF	1993,95-01	RBT/BNT	22
Sycamore Creek	Monroe	CNF	1994-95,97-98	RBT/BKT	6
Bald River[3]	Monroe	CNF	1991-00	RBT/BNT/BKT	31
Henderson Branch	Monroe	CNF	1996	RBT/BNT/BKT	2
Brookshire Creek	Monroe	CNF	1996	BKT	3
Laurel Branch	Monroe	CNF	1997	RBT/BNT	1
North River[2]	Monroe	CNF	1991-01	RBT/BNT	33
Total streams = 14				**Total samples =**	**112**
French Broad River					
Brown Gap Creek	Cocke	Private	1991	BKT	1
Middle Prong Gulf Creek	Cocke	Private	1991	BKT	1
Gulf Fork Big Creek	Cocke	Private	1993	RBT	1
Trail Fork Big Creek	Cocke	CNF	1996, 2001	RBT	2
Wolf Creek	Cocke	CNF	1993	RBT	2
Sinking Creek	Cocke	Private	1999	RBT	1
Dunn Creek	Sevier	Private	1993	RBT	1
Little Paint Creek	Greene	CNF	1993	BKT	1
Dry Fork	Cocke	CNF	1994	BKT/RBT	2
Sawmill Branch	Greene	CNF	1999	BKT/BNT	1
Paint Creek	Greene	CNF	1992,94,95	BNT/RBT	3
Total streams = 11				**Total samples =**	**16**

Table A-1 (cont.). Wild trout streams sampled quantitatively during 1991-2001.

Stream	County	Location	Year	Primary species[1]	Total samples
Nolichucky River					
Granny Lewis Creek	Unicoi	CNF	1991	RBT	2
Clark Creek	Unicoi	CNF	1991	RBT	1
Broad Shoal Creek	Unicoi	CNF	1991	RBT	1
Rock Creek	Unicoi	CNF	1991	RBT/BKT	1
Right Prong Rock Creek	Unicoi	CNF	1998	RBT	1
Jones Branch	Unicoi	CNF	1991	BKT	1
Sarvis Cove Creek	Greene	CNF	1991	RBT/BKT	1
Squibb Creek	Greene	CNF	1991	RBT/BKT	1
Jennings Creek	Greene	CNF	1992	RBT	1
Round Knob Branch	Greene	CNF	1996	BKT	1
Davis Creek	Greene	CNF	1992	BKT	1
Briar Creek[2]	Washington	CNF	1992,95-01	RBT/BKT	8
Ramsey Creek	Unicoi	Private	1996	RBT	1
W. Fork Dry Creek	Greene	CNF	1992	BKT	1
Dry Creek	Greene	CNF	1992	RBT	1
Higgins Creek (lower)	Unicoi	Private	1992,95	BKT/RBT	2
Red Fork	Unicoi	CNF	1998	RBT	1
Clear Fork	Unicoi	CNF	1993	BKT	1
Painter Creek	Washington	Private	1993	RBT	1
Sill Branch	Unicoi	CNF	1994	RBT	1
Devil Fork	Unicoi	CNF	1999	RBT	1
Longarm Branch	Unicoi	CNF	1997	RBT	1
Horse Creek	Greene	CNF	1994	RBT	1
N. Indian Creek	Unicoi	CNF	1994-95	RBT/BNT	2
Tumbling Creek	Unicoi	Private	1995	RBT	1
Big Bald Creek	Unicoi	Private	1996	RBT	1
Rice Creek	Unicoi	Private	1995	RBT	1
Mill Creek	Unicoi	CNF	1996	RBT	1
Big Branch	Unicoi	Private	1996	RBT	1
Dry Creek	Unicoi	CNF	1997	RBT	1
Rocky Fork[2]	Unicoi/Greene	Private	1991-01	RBT/BKT	22
Total streams = 31				**Total samples =**	**62**
Watauga River					
Cove Creek	Carter	Private	1991	BKT	1
Panther Branch	Carter	CNF	1996	BKT	1
Five Poplar Branch	Carter	Private	2000	RBT	1
Toms Branch	Carter	Private	1991	BKT	1
Middle Branch	Carter	Private	1991	BKT	1
Tiger Creek	Carter	CNF	1991, 99	RBT/BKT	2

Table A-1 (cont.). Wild trout streams sampled quantitatively during 1991-2001.

Stream	County	Location	Year	Primary species[1]	Total samples
Watauga River (cont.)					
Bill Creek	Carter	CNF	1991	BKT	1
North Fork Stony Creek	Carter	CNF	1991	BKT	1
George Creek	Carter	State	1991	BKT	1
Clarke Creek	Carter	Private	1992	BKT	1
Stony Creek	Carter	CNF	1992,95	RBT/BKT/BNT	3
Little Stony Creek	Carter	CNF	1992	BKT	1
Little Laurel Branch	Carter	CNF	1992	BKT	1
Furnace Creek	Johnson	Private	1992	BKT	1
Campbell Creek	Johnson	Private	1993	RBT	1
Little Stony Creek[4]	Carter	CNF	1993	RBT	1
Wagner Branch	Carter	CNF	1993	BKT/BNT	1
Forge Creek	Johnson	Private	1993	RBT/BKT	2
Little Laurel Fork	Carter	CNF	1994	BKT	1
Heaton Branch	Carter	Private	1994	RBT	1
R. Prong Middle Branch[2]	Carter	CNF	1994, 97-01	BKT	6
Simerly Creek	Carter	Private	1994	RBT	1
Mill Creek	Carter	Private	1994	BKT	1
Big Dry Run	Johnson	Private	1994	RBT	1
Camp 10 Branch	Carter	CNF	1995	BKT	1
Trivett Branch	Carter	Private	1996	BNT	1
Sally Cove Creek	Carter	Private	1995	RBT	1
Slabtown Branch	Johnson	Private	1995	RBT	1
Doe River	Carter	Private	1995-99	RBT/BKT/BNT	8
Heaton Creek	Carter	Private	2000	RBT	1
Buck Creek	Carter	CNF/Private	1997	RBT	2
Roan Creek	Johnson	Private	1997	RBT/BKT	2
Buffalo Creek	Unicoi	Private	1998	RBT	1
L. Prong Hampton Creek[2]	Carter	State	1994-01	RBT/BKT	18
Doe Creek[2]	Johnson	Private	1993-01	RBT	10
Laurel Fork[3]	Carter	CNF	1991-01	BNT	21
Total streams = 36				**Total samples =**	**100**
South Fork Holston River					
Little Jacob Creek	Sullivan	CNF	1991, 2000	RBT	2
Fishdam Creek	Sullivan	CNF	1991	RBT	1
Birch Branch[2]	Johnson	CNF/Private	1991,95-01	BKT/RBT	8
Johnson Blevins Branch	Johnson	Private	1991	BKT	1
Jim Wright Branch	Johnson	Private	1991	BKT	1
Big Jacob Creek	Sullivan	CNF	1992	RBT	1
Lyons Branch	Johnson	CNF	1992	RBT	1

Table A-1 (cont.). Wild trout streams sampled quantitatively during 1991-2001.

Stream	County	Location	Year	Primary species[1]	Total samples
South Fork Holston River (cont.)					
Gentry Creek[2]	Johnson	CNF	1992,96-01	RBT/BKT	8
Kate Branch	Johnson	CNF	2000	BKT	1
Grindstone Branch	Johnson	CNF	1996	BKT	1
E. Fork Beaverdam Creek	Johnson	CNF	1992	BKT	1
Rockhouse Run	Sullivan	CNF	1993	BKT	1
Valley Creek	Johnson	CNF	1993	BKT	1
Heaberlin Branch	Johnson	CNF	1993	BKT	1
Marshall Branch	Johnson	CNF	1999	BKT	1
Laurel Creek[2]	Johnson	CNF	1993-94, 01	RBT/BNT	3
Chalk Branch	Johnson	CNF	1994	BKT	1
Maple Branch	Johnson	CNF	1994	BKT	1
Big Creek	Sullivan	CNF	1994	RBT	1
Fagall Branch	Johnson	CNF	1995	BKT	1
Owens Branch	Johnson	CNF	1995	RBT/BNT	1
Roaring Branch	Johnson	Private	2001	RBT	1
Beaverdam Creek[2]	Johnson	CNF	1991-01	RBT/BNT	22
Total streams = 23				**Total samples =**	**61**
Total streams (all) = 122				**Total samples (all) =**	**358**

[1]RBT = rainbow trout; BNT = brown trout; BKT = brook trout.

[2]Current monitoring stream.

[3]Previous monitoring stream. The entry for Bald River includes a site sampled in the allopatric brook trout zone in 1992.

[4]Watauga Lake tributary.